Recommendation T/R 24-01 (The Hague 1972, revised in Puerto de la Cruz 1974, Stockholm 1976 and 1977. Ostende 1979, Vienna 1982, Cannes 1983 and Copenhagen 1987)

SPECIFICATIONS OF EQUIPMENT FOR USE IN THE LAND MOBILE SERVICE

Recommendation proposed by the “Radiocommunications” Working Group T/WG, 3 (R)

Revised text of the Recommendation adopted by the “Telecommunications” Committee:
"The European Conference of Posts and Telecommunications Administrations,

considering

(a) that the land mobile service is expanding at a very rapid rate,

(b) that it is necessary in order to achieve effective utilisation of the frequency spectrum and for the purpose of reducing interference to have adequate technical specifications for equipment in this service,

(c) that the technical characteristics laid down by the different Administrations should be harmonised insofar as possible,

(d) that it would be of benefit to Administrations, users and manufacturers if approval test reports could be exchanged between Administrations where the latter so desired,

(e) that mutual acceptance of these approval reports and certificates should be the goal to be aimed for,

(f) that radiotelephone equipment utilising phase or frequency modulation is most common,

(g) that it is, therefore, desirable to harmonise first of all the specifications of frequency or phase modulated equipment intended for use in the land mobile service,

(h) that the harmonised technical characteristics referred *to* in point (g) may serve as a basis for additional or modified specifications for other types of equipment in the land mobile service, e.g. equipment in the public mobile service, pocket-sized devices, amplitude modulated devices, etc.,

recommends

1. that CEPT member Administrations adopt and include as soon as possible in their national specifications relating to equipment in the land mobile service the technical specifications appearing in Annexes I, III or V of this Recommendation, depending on the individual case,

2. that where CEPT member Administrations wish to enact national regulations concerning specifications relating to quality and stability of transmission, they take into account the specifications appearing in Annexes II or IV, depending on the individual case.”

Annex I
“Technical characteristics and test conditions for radio equipment in the land mobile service.”
Annex II
“Technical characteristics of radio equipment in the land mobile service with regard to quality and stability of transmission.”
Annex III
“Technical characteristics and test conditions for radio equipment with in built antenna in the land mobile service.”

N. B.
Member Administrations are not obliged under the CEPT statute to implement Conference Recommendations.

Annex IV

"Technical characteristics of radio equipment with inbuilt antenna in the land mobile service with regard to quality and stability of transmission."

Annex V
"Technical characteristics and test conditions for radio equipment in the land mobile service not using voice modulation or using voice and non-voice modulation combined with a device permitting a specific response to be obtained in the receiver."

Annex I

Technical characteristics and test conditions for radio equipment in the land mobile service

Note. Text approved by telecommunications commission at Stockholm (1977), Vienna (1982) and Cannes (1983).

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1 SCOPE OF THE SPECIFICATIONS

These technical specifications cover the minimum characteristics considered necessary in order to make the best use of the available frequencies. They do not necessarily include all the characteristics, which may be required by a user, nor do they necessarily represent the optimum performance achievable. They apply to frequency modulation or phase modulation systems as chosen by each Administration for the land mobile service, operating on radio frequencies between 30 MHz and 1,000 MHz, which channel separations of 12.5 kHz, 20 kHz and 25 kHz. Additional specifications or amendments are required for equipment such as that:

a) for transmission of signals other than speech (see Annex V to this Recommendation);
b) for equipment with integral antenna (see Annex III to this Recommendation).

Additional specifications or amendments may be required for equipment such as that:

c) intended for connection to public radiotelephony networks;
d) using other types of modulation;
e) e) for portable use, including pocket sized equipment.

In these specifications different requirements are given for the different radio frequency bands, channel separations, etc., where appropriate.

2 TEST CONDITIONS, POWER SOURCES AND AMBIENT TEMPERATURES

2.1 Normal and extreme test conditions

Type-approval tests shall be made under normal test conditions, and also, where stated, under extreme test conditions.
The test conditions and procedures shall be as specified in Clauses 2.2 to 2.5.

2.2 Test power source

During type-approval tests the power source of the equipment shall be replaced by a test power source, capable of producing normal and extreme test voltages as specified in Clauses 2.3.2. and 2.4.2. The internal impedance of the test power source shall be low enough for its effect on the test results to be negligible. For the purpose of tests, the voltage of the power source shall be measured at the input terminals of the equipment.
If the equipment is provided with a permanently connected power cable, the test voltage shall be that measured at the point of connection of the power cable to the equipment.
In equipment with incorporated batteries the test power source shall be applied as close to the battery terminals as practicable.
During tests, the power source voltages shall be maintained within a tolerance of ± 3% relative to the voltage at the beginning of each test.

2.3 Normal test conditions

2.3.1 Normal temperature and humidity

The normal temperature and humidity conditions for tests shall be any convenient combination of temperature and humidity within the following ranges:
Temperature: + 15° C to + 35° C
Relative humidity: 20% to 75%

Note. When it is impracticable to carry out the tests under the conditions stated above, a note to this effect, stating the actual temperature and relative humidity during the tests, shall be added to the test report.

2.3.2 Normal test power source

2.3.2.1 Mains voltage

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of these specifications, the nominal voltage shall be the declared voltage or any of the declared voltages for which the equipment was designed. The frequency of the test power source corresponding to the AC mains shall be between 49 and 51 Hz.

2.3.2.2 Regulated lead-acid battery power sources on vehicles

When the radio equipment is intended for operation from *the usual* types of regulated lead-acid battery power source of vehicles, the normal test voltage shall be 1.1 times the nominal voltage of the battery (6 volts, 12 volts, etc.).

2.3.2.3 Other power sources

For operation from other power sources or types of battery (primary or accumulator). the normal test voltage shall be that declared by the equipment manufacturer.

2.4 Extreme test conditions

2.4.1 Extreme temperatures

For tests at extreme temperatures, measurements shall be made in accordance with the procedures specified in Clause 2.5, at the upper and lower temperatures of one of the following ranges:
- 25° C to + 55° C
- 20° C to + 55° C
- 10° C to + 55° C
+ 5° C to + 40° C
Type-approval test reports should state which range is applicable.

2.4.2 Extreme test values

2.4.2.1 Mains voltage

The extreme test voltage for equipment to be connected to an AC mains source shall be the nominal mains voltage ± 10%. The frequency of the test power source shall be between 49 and 51 Hz.

2.4.2.2 Regulated lead-acid battery power sources on vehicles

When the equipment is intended for operation from the usual types of regulated lead-acid battery power sources on vehicles the extreme test voltages shall be 1.3 and 0.9 times the nominal voltage of the battery (6 volts, 12 volts, etc.).

2.4.2.3 Other power sources

The lower extreme test voltage for equipment with power sources using primary batteries shall be as follows:

1. For the Leclanché type of battery:
   0.85 times the nominal voltage of the battery;
2. For the mercury type of battery:
   0.9 times the nominal voltage of the battery;
3. For other types of primary batteries:
   end point voltage declared by the equipment manufacturer.

For equipment using other power sources, or capable of being operated from a variety of power sources, the extreme test voltages shall be those agreed between the equipment manufacturer and the testing authority and shall be recorded with the results.

2.5 Procedure for tests at extreme temperatures

2.5.1 Test procedure

Before measurements are made the equipment shall have reached thermal balance in the test chamber. The equipment shall be switched off during the temperature stabilising period.[1] If the thermal balance is not checked by measurements, a temperature stabilising period of at least one hour, or such period as may be decided by the testing authority, shall be allowed. The sequence of measurements shall be chosen, and the humidity content in *the test* chamber shall be controlled so that excessive condensation does not occur.

2.5.1.1 Procedure for equipment designed for continuous operation

If the manufacturer states that the equipment is designed for continuous operation, the test procedure shall be as follows:

[1] *Note.* In the case of equipment containing temperature stabilisation circuits designed to operate continuously, the temperature stabilisation circuits may be switched on for 15 minutes after thermal balance has been obtained, and the equipment shall then meet the specified requirements. For such equipment the manufacturer shall provide for the power source circuit feeding the crystal oven to be independent of the power source to the rest of the equipment.

Before tests at the upper temperature the equipment shall be placed in the test chamber and left until thermal balance[1]) is attained. The equipment shall then be switched on in the transmit condition for a period of half an hour after which the equipment shall meet the specified requirements.
For tests at the lower temperature, the equipment shall be left in the test chamber until thermal balance[1]) is attained, then switched to the standby or receive condition for a period of 1 minute after which the equipment shall meet the specified requirements.

2.5.1.2 Procedure for equipment designed for intermittent operation

If the manufacturer states that the equipment is designed for intermittent operation, the test procedure shall be as follows:
Before tests at the upper temperature the equipment shall be placed in the test chamber and left until thermal balance[1]) is attained. The equipment shall then be switched on for one minute in the transmit condition, followed by four minutes in the receive condition, after which the equipment shall meet the specified requirements.
For tests at the lower temperature, the equipment shall be left in the test chamber until thermal balance[1]) is attained, then switched to the standby or receive condition for one minute after which the equipment shall meet the specified requirements.

3 GENERAL CONDMONS

3.1 Arrangements for test signals applied to the receiver input

Sources of test signals for application to the receiver input shall be connected in such a way that the impedance presented to the receiver input is 50 ohms.
This requirement shall be met irrespective of whether one or more signals are applied to the receiver simultaneously.
The levels of the test signals shall be expressed in terms of the e.m.f. at the receiver input terminals.
The effects of any intermodulation products and noise produced in the signal generators should be negligible.

3.2 Receiver mute or squelch facility

If the receiver is equipped with a mute or squelch circuit, this shall be made inoperative for the duration of the type-approval tests.

3.3 Receiver rated audio output power

The rated audio output power shall be the maximum power, declared by the manufacturer, for which all the requirements of these specifications are met. With normal test modulation (Clause 3.4.), the autio output power shall be measured in a resistive load, simulating the load with which the receiver normally operates. The value of this load shall he declared by the manufacturer.

3.4 Normal test modulation

For normal test modulation, the modulation frequency shall be 1 kHz and the resulting frequency deviation shall be 60% of the maximum permissible frequency deviation (Clause 4.3.l.). The test signal shall be substantially free from amplitude modulation.

3.5 Artificial antenna

Tests on the transmitter shall be carried out with a non-reactive non-radiating load of 50 ohms connected to the antenna terminals.

3.6 Tests of equipment with a duplex filter

If the equipment is provided with a built-in duplex filter or a separate associated filter, the requirements of these specifications shall be met when the measurements are carried out using the antenna terminals of this filter.

[1]) See Note to 2.5.1

3.7 Test site and general arrangements for measurements involving the use of radiated fields

(For general guidance see also Appendix A.)

3.7.1 Test site

The test site shall be on a reasonably level surface or ground.
At one point on the site, a ground plane of at least 5 metres diameter shall be provided. In the middle of this ground plane, a non-conducting support, capable of rotation through 360° in the horizontal plane, shall be used to support the test sample at 1.5 metres above the ground plane. The test site shall be large enough to allow the erection of a measuring or transmitting antenna at a distance of $\lambda/2$ or 3 metres whichever is the greater. The distance actually used shall be recorded with the results of the tests carried out on the site.
Sufficient precautions shall be taken to ensure that reflections from extraneous objects adjacent to the site and ground reflections do not degrade the measurement results.

3.7.2 Test antenna

The test antenna is used to detect the radiation from both the test sample and the substitution antenna, when the site is used for radiation measurements; where necessary, it is used as a transmitting antenna, when the site is used for the measurement of receiver characteristics. This antenna is mounted on a support such as to allow the antenna to be used in either horizontal or vertical polarisation and for the height of its centre above ground to be varied over the range 1-4 metres. Preferably test antennas with pronounced directivity should be used. The size of the test antenna along the measurement axis shall not exceed 20% of the measuring distance.
For radiation measurements, the test antenna is connected to a test receiver, capable of being tuned to any frequency under investigation and of measuring accurately the relative levels of signals at its input. When necessary (for receiver measurements) the test receiver is replaced by a signal source.

3.7.3 Substitution antenna

The substitution antenna shall be a $\lambda/2$ dipole, resonant at the frequency under consideration, or a shortened dipole, calibrated to the $\lambda/2$ dipole.. The centre of this antenna shall coincide with the reference point of the test sample it has replaced. This reference point shall be the volume centre of the sample when its antenna is mounted inside the cabinet, or the point where an external antenna is connected to the cabinet.
The distance between the lower extremity of the dipole and the ground shall be at least 30 cm.
The substitution antenna shall be connected to a calibrated signal generator when the site is used for radiation measurements and to a calibrated measuring receiver when the site is used for measurement of receiver characteristics. The signal generator and the receiver shall be operating at the frequencies under investigation and shall be connected to the antenna through suitable matching and balancing networks.

3.7.4 Alternative indoor site

When the frequency of the signals being measured is greater than 80 MHz, use may be made of an indoor site. If this alternative site is used, this shall be recorded in the test report.
The measurement site may be a laboratory room with a minimum area of 6 metres by 7 metres and at least 2.7 metres in height.
Apart from the measuring apparatus and the operator. the room shall be as free as possible from reflecting objects other than the walls, floor and ceiling.

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The site arrangement is in principle shown in Figure I.1 (T/R 24-01).

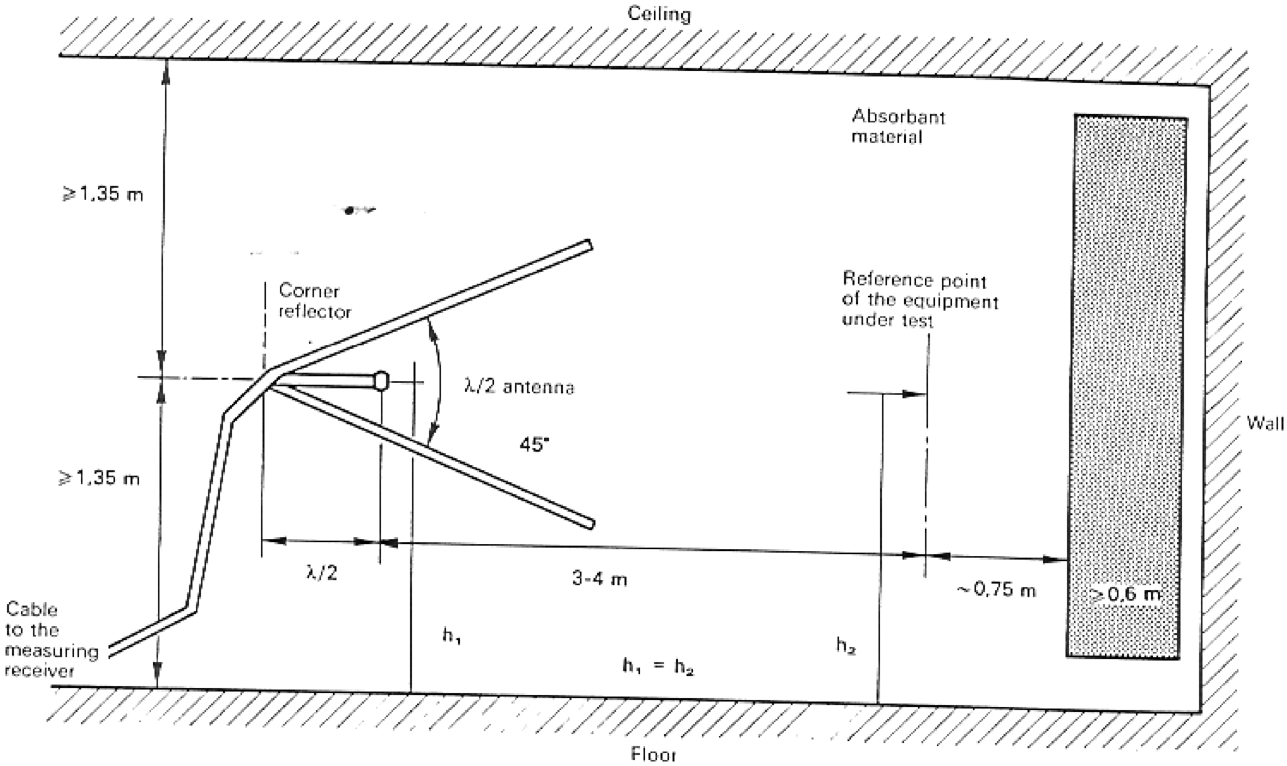

Figure I.1 (T/R 24-01). Indoor site arrangement (shown for horizontal polarization).

The potential reflections from the wall behind the equipment under test are reduced by placing a barrier of absorbent material in front of it. The corner reflector around the test antenna is used to reduce the effects of reflections from the opposite wall and from the floor and ceiling in the case of horizontally polarized measurements.

Similarly, the corner reflector reduces the effects of reflections from the side walls for vertically polarized measurements.

For the lower part of the frequency range (below approximately 175 MHz) no corner reflector or absorbent barrier is needed.

For practical reasons, the λ/2 antenna in Figure I.1 (T/R 24-01) may be replaced by an antenna of constant length, provided that this length is between λ/4 and λ as the frequency of measurement and the sensitivity of the measuring system is sufficient. In the same way the distance of λ/2 to the apex may be varied.

The test antenna, test receiver, substitution antenna and calibrated signal generator are used in a way similar to that of the general method.

To ensure that errors are not caused by the propagation path approaching the point at which phase cancellation between direct and the remaining reflected signals occurs, the substitution antenna shall be moved through a distance of ± 10 cm in the direction of the test antenna as well as in the two directions perpendicular to this first direction. If these changes of distance cause a signal change of greater than 2 dB, the test sample should be resited until a change of less than 2 dB is obtained.

3.8. **Arrangement for test signals at the input of the transmitter**

For the purpose of this specification, the transmitter audio-frequency modulation signal shall be supplied by a generator applied at the connections of the microphone insert, unless otherwise stated.

4 TRANSMITTER

4.1 Frequency error

4.1.1 Definition

The frequency error of the transmitter is the difference between the measured carrier frequency and its nominal value.

4.1.2 Method of *measurement*

The carrier frequency shall be measured in the absence of modulation with the transmitter connected to an artificial antenna (Clause 3.5.). The measurement shall be made under normal test conditions (Clause 2.3.) and extreme test conditions (Clauses 2.4.1. and 2.4.2. applied simultaneously).

4.1.3 Limits

The frequency error shall not exceed the values given in Table I.1 (T/R 24-01), in both normal and extreme test conditions, or in any intermediate set of conditions.

Channel separation (kHz)	Frequency tolerance (kHz)				
	Below 50 MHz	50 to 100 MHz	100 to 300 MHz	300 to 500 MHz	500 to 1,000 MHz
20 and 25	± 0.6	± 1.35	± 2.0	± 2.5	± 2.5 (b) (c)
12.5	± 0.6	± 1.0 (a)	± 1.0 (a) (B) ± 1.5 (a) (b)	± 1.0 (b) (B) ± 1.0 (b) (c) (M)	Not specified

Table I.1 (T/R 24-01)

(B) = Base station. (M) = Mobile station.
(a) Even tighter tolerances are desirable.
(b) The tolerances shown in the table are tentative.
(c) For portable equipments having integral power supplies, the tolerance given shall not be exceeded over a temperature range of 0-30° C. Under extreme temperature conditions (Clause 2.4.1) the frequency error shall not exceed:
± 2.5 kHz for a channel separation of 12.5 kHz between 300 and 500 MHz
± 3.0 kHz for channel separations of 20 and 25 kHz between 500 and 1.000 MHz.

4.2 Carrier power

It is assumed that Administrations will state the maximum permitted value of effective radiated power; this could be a condition for issuing the licence.

4.2.1 Definition

The transmitter carrier power is the mean power delivered to the artificial antenna during a radio frequency cycle, without modulation.
The rated output power is the carrier power declared by the manufacturer.

4.2.2 Method of measurement

The transmitter shall be connected to an artificial antenna (Clause 3.5.), and the power delivered to this artificial antenna shall be measured.
The measurements shall be made under normal test conditions (Clause 2.3.) and extreme test conditions (Clauses 2.4.1. and 2.4.2. applied simultaneously).

4.2.3 Limits

The carrier output power under normal test conditions shall be within ± 1.5 dB of the rated output power. The carrier output power under extreme test conditions shall be within + 2 dB and - 3 dB of the rated output power.

Note 1. If the equipment is designed to operate with different carrier powers. the rated power for each power level or range of levels must be declared by the manufacturer. The power adjustment control shall not be accessible to the user.
Note 2. The requirements of this specification must be met for all power levels at which the transmitter can operate.

4.3 Frequency deviation

The frequency deviation is the maximum difference between the instantaneous frequency of the modulated radio frequency signal and the carrier frequency in the absence of modulation.

4.3.1 Maximum permissible frequency deviation

4.3.1.1. Definition
The maximum permissible frequency deviation is the maximum value of frequency deviation stipulated in these specifications for the separation between adjacent channels.

4.3.1.1 Method of measurement

The frequency deviation shall be measured at the output of the transmitter connected to an artificial antenna (Clause 3.5.), by means of a deviation meter capable of measuring the maximum deviation, including that due to any harmonies and intermodulation products which may be generated in the transmitter.
The modulation frequency shall be varied between the lowest frequency considered to be appropriate, and 3 kHz[2] . The level of this test signal shall be 20 dB above the level of the normal test modulation (Clause 3.4.).

4.3.1.2 Limits

The maximum permissible frequency deviation shall be as in Table I.2 (T/R 24-01) below:

Channel separation (kHz)	Maximum permissible Frequency deviation (kHz)
25	± 5
20	± 4
12.5	± 2.5

Table I.2 (T/R 24-01)

4.3.2 Response of the transmitter to modulation frequencies exceeding 3 kHz[2])

4.3.2.1 Definition

The response of the transmitter to modulation frequencies exceeding 3 kHz[2]) is the expression or the frequency deviation in relation to modulation frequencies exceeding 3 kHz[2]).

4.3.2.2 Method of measurement

The transmitter shall be operated under normal test conditions (Clause 2.3.), and loaded in accordance with Clause 3.5. The transmitter shall be modulated by normal test modulation (Clause 3.4.). With a constant input level of the modulation signal, the modulation frequency shall be varied between 3 kHz[2]) and a frequency equal to the channel separation for which the equipment is intended, and the frequency deviation shall be measured by means of a deviation meter as described in Clause 4.3.1.2.

4.3.2.3 Limits

The frequency deviation at modulation frequencies between 3 kHz[2]) and 6 kHz shall not exceed the frequency deviation at a modulation frequency at 3 kHz[2]). At 6 kHz the deviation shall be at least 6 dB below the deviation at a modulation frequency of 1 kHz. The frequency deviation at modulation frequencies between 6 kHz and a frequency equal to the channel separation for which the equipment is intended shall not exceed that which would be given by a linear representation of the frequency deviation (dB) in relation to the modulation frequency, starting at a point where the modulation frequency is 6 kHz and the deviation 6 dB below the value at 1 kHz and having a slope of 14 dB per octave, the frequency deviation diminishing as the modulation frequency is increased.

4.4 Adjacent channel power

4.4.1 Definition

The adjacent channel power is that part of the total power output of a transmitter under defined conditions of modulation, which falls within a specified pass band centred on the nominal frequency of either of the adjacent channels. This power is the sum of the mean power produced by the modulation, hum and noise of the transmitter.

[2] 2.55 kHz for transmitters intended for 12.5 kHz channel separation.

4.4.2 Methods of measurement

4.4.2.1 General

Two methods are proposed, the results of which are equivalent. Administrations are requested to use one or both methods. The method applied should be stated in the test reports.

4.4.2.2 Method of measurement using a power measuring receiver

The adjacent channel power may be measured with a power measuring receiver Clause 4.4.2.3. (Referred to in Clauses 4.4.2.2. and 4.4.2.3. as the “receiver”.)

(a) The transmitter shall be operated at the carrier power determined in Clause 4.2. under normal test conditions (Clause 2.3.). The output of the transmitter shall be linked to the input of the “receiver” by a connecting device such that the impedance presented to the transmitter is 50 ohms and the level at the “receiver” input is appropriate.

(b) With the transmitter unmodulated[3], the tuning of the “receiver” shall be adjusted so that a maximum response is obtained. This is the 0 dB response point. The “receiver” attenuator setting and the reading of the meter shall be recorded.

(c) The tuning of the “receiver” shall be adjusted away from the carrier so that the “receiver” -6 dB response nearest the transmitter carrier frequency is located at a displacement from the nominal carrier frequency as given in the following table:

Channel spacing (kHz)	Specified necessary bandwidth (kHz)	Displacement of the 6 dB point
25	16	17
20	14	13
12.5	8.5	8.25

Table I.3 (T/R 24-01)

(d) The transmitter shall be modulated with 1.250 Hz at a level, which is 20 dB higher than that required to produce 60% of the maximum permissible deviation (Clause 4.3.1.).

(e) The “receiver” variable attenuator shall be adjusted to obtain the same meter reading as in step (b) or a known relation to it.

(f) The ratio of adjacent channel power to carrier power is the difference between the attenuator settings in steps (b) and (e), corrected for any differences in the reading of the meter.

(g) The measurement shall be repeated with the “receiver” tuned to the other side of the carrier.

4.4.2.3 Power measuring receiver specification

The power measuring receiver consists of a mixer, an IF-filter, an oscillator, an amplifier, a variable attenuator and an rms value indicator. Instead of the variable attenuator with the rms value indicators it is also possible to use a dB-calibrated rms voltmeter. The technical characteristics of the power measuring receiver are given below:

[3] The measurement may be made with the transmitter modulated with normal test modulation (Clause 3.4.), in which case this fact shall be recorded with the test results.

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4.4.2.3.1. IF-filter

The IF-filter shall be within the limits of the following selectivity characteristic.

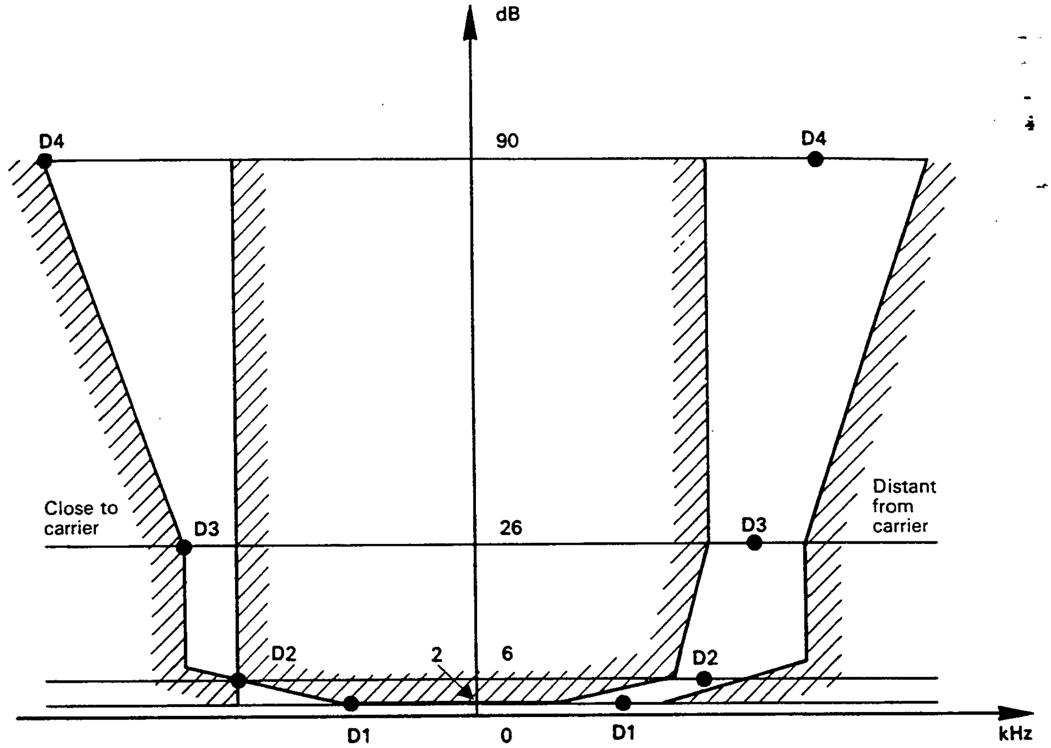

Figure I.2 (T/R 24-01).

Depending on the channel spacing, the selectivity characteristic shall keep the following frequency separations from the nominal centre frequency of the adjacent channel:

Channel spacing (kHz)	Frequency separation of filter curve from nominal centre frequency of adjacent channel (kHz)			
	D1	D2	D3	D4
12.5	3	4.25	5.5	9.5
20	4	7.0	8.25	12.25
25	5	8.0	9.25	13.25

Table I.4 (T/R 24-01).

Depending on the channel spacing, the attenuation points shall not exceed the following tolerances:

Channel spacing (kHz)	Tolerance range (kHz)			
	D1	D2	D3	D4
12.5	+1.35	±0.1	−1.35	−5.35
20	+3.1	±0.1	−1.35	−5.35
25	+3.1	±0.1	−1.35	−5.35

Table I.5 (T/R 24-01). Attenuation points close to carrier.

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Channel spacing (kHz)	Tolerance range (kHz)			
	D1	D2	D3	D4
12.5	± 2.0	± 2.0	± 2.0	+ 2.0 - 6.0
20	± 3.0	± 3.0	± 3.0	+ 3.0 - 7.0
25	± 3.5	± 3.5	± 3.5	+ 3.5 - 7.5

Table 1.6 (T/R 24-01). Attenuation points distant from carrier

The minimum attenuation of the filter outside the 90 dB attenuation points must be equal to or greater than 90 dB.

4.4.2.3.1 Attenuation indicator

The attenuation indicator shall have a minimum range of 80 dB and a reading accuracy of 1 dB. With a view to future regulations an attenuation of 90 dB or more is recommended.

4.4.2.3.2 Rms value indicator

The instrument shall accurately indicate non-sinusoidal signals in a ratio of 10: 1 between peak value and rms value.

4.4.2.3.3 Oscillator and amplifier

The oscillator and the amplifier shall be designed in such a way that the measurement of the adjacent channel power of a low-noise unmodulated transmitter, whose self-noise has a negligible influence on the measurement result, yields a measured value of ≤ -90 dB for channel spacing of 20 and 25 kHz and of ≤ -80 dB for a channel spacing of 12.5 kHz referred to the carrier of the oscillator.

4.4.2.4 Method of measurement using a spectrum analyser

The adjacent channel power may be measured with a spectrum analyser which conforms to Clause 4.4.2.5. The transmitter shall be operated at the carrier power determined in Clause 4.2. under normal test conditions (Clause 2.3.). The output of the transmitter shall be linked to the input of a spectrum analyser by a connecting device such that the impedance presented to the transmitter is 50 ohms and the level at the spectrum analyser input is appropriate. The transmitter shall be modulated by a test modulation signal having a frequency of 1.250 Hz and a level which is 20 dB higher than that required to produce 60% of the maximum permissible frequency deviation (Clause 4.3.1). The spectrum analyser shall be so adjusted that the spectrum of the transmitter output, including that part which lies within the adjacent channels, is displayed.

For the purpose of this test, the bandwidth of a receiver of the type normally used in the system shall be taken to be:

(a) 16 kHz for 25 kHz channel separation;
(b) 14 kHz for 20 kHz channel separation;
(c) 8.5 kHz for 12.5 kHz channel separation,

with a tolerance of ± 10%.

The centre frequency of the bandwidth within which measurements are to be made shall have a separation from the nominal carrier frequency of the transmitter equal to the channel separation for which the equipment is intended.

The adjacent channel power is the sum of the power levels of each of the discrete components and of the noise in the appropriate bandwidth.

This sum may be calculated manually or automatically or an automatic power level integrating device may be used to obtain it (see Clause 4.4.2.6.).

In the latter case, the relative power level of the carrier and its sidebands is initially measured by integration in the appropriate bandwidth, centred on the nominal frequency. The integration is repeated at this bandwidth centred on the nominal frequency of the adjacent channel and the input level of the carrier signal increased until the same power level at the output of the device is obtained.

The difference in the input levels, in dB, is the ratio of the adjacent channel power to the carrier output power.

The adjacent channel power is determined by applying this ratio to the carrier output power as measured in Clause 4.2. or by a direct substitution measurement using a calibrated source.

The measurement shall be repeated for the other adjacent channel.

4.4.2.5 Spectrum analyser specification

The specification shall include the following requirements:
It shall be possible, using a resolution bandwidth of 1 kHz, to measure the amplitude of a signal or noise at a level 3 dB or more above the noise level of the spectrum analyser, as displayed on the screen, to an accuracy of ±2 dB in the presence of a signal separated in frequency by:

(a) 10 kHz, at a level 90 dB above that of the signal to be measured for 25 and 20 kHz channel separations, and
(b) 6.25 kHz, at a level 80 dB above that of the signal to be measured for a 12.5 kHz channel separation. The reading accuracy of the frequency marker shall be within ± 2% of the channel separation.

The accuracy of relative amplitude measurements shall be within ± 1 dB.
It shall be possible to adjust the spectrum analyser so that two components with a frequency difference of 1 kHz are displayed separately.

4.4.2.6 Integrating and power summing device

The integrating and power device is connected to the video output of the spectrum analyser, described in Clause 4.4.2.5.
It shall be possible to summate the effective power of all discrete components and the noise power in the selected bandwidth and to measure this as a ratio to the carrier power.
The position and the width of the integration range selected can be indicated on the spectrum analyser by brightening the trace.
When power levels as low as 50 nanowatts are measured, the output of the device should exceed the internal noise level by 10 dB. The dynamic range shall permit measurement of the values required under Clause 4.4.3. with a margin of at least 10 dB.

4.4.3 Limits

For channel separations of 20 kHz and 25 kHz the adjacent channel power shall not exceed a value of 70 dB below the carrier power of the transmitter without any need to descend below 0.2 microwatt. For channel separations of 12.5 kHz, the adjacent channel power shall not exceed a value of 60 dB below the transmitter carrier power without any need to descend below 0.2 microwatt.

4.5 Spurious emissions

4.5.1 Definition

Spurious emissions are emissions at frequencies other than those of the carrier and sidebands associated with normal modulation.
The level of spurious emissions shall be measured as:

(a) their power level in a transmission line or antenna, and
(b) their effective radiated power when radiated by the cabinet and structure of the equipment. (b) is also known as “cabinet radiation”.

4.5.2 Method of measuring the power level

Spurious emissions shall be measured as the power level of any discrete signal delivered into a 50 ohms load. This may be done by connecting the transmitter output through an attenuator to a spectrum analyser or selective voltmeter, or by monitoring the relative levels of the spurious signals delivered to an artificial antenna (Clause 3.5.).
The transmitter shall be unmodulated and the measurements made over the frequency range 100 kHz to 4.000 MHz, except for the channel on which the transmitter is intended to operate and its adjacent channels. The measurements shall be repeated with the transmitter modulated with normal test modulation (Clause 3.4.). The measurements shall be repeated with the transmitter in standby.

4.5.3 Method of measuring the effective radiated power

On a test site fulfilling the requirements of Clause 3.7., the sample shall be placed at the specified height on a non-conducting support. The transmitter shall be operated at the carrier power as specified under Clause 4.2., delivered to an artificial antenna (Clause 3.5.) without modulation.
Radiation of any spurious components shall be detected by the test antenna and receiver, over the frequency range 30-4.000 MHz, except for the channel on which the transmitter is intended to operate and its adjacent channels.

At each frequency at which a component is detected, the sample shall be rotated to obtain maximum response and the effective radiated power of that component determined by a substitution measurement. The measurements shall be repeated with the test antenna in the orthogonal polarisation plane. The measurements shall be repeated with the transmitter modulated by standard test modulation (Clause 3.4.). The measurements shall be repeated with the transmitter in standby.

4.5.4 Limits

The power of any spurious emission shall not exceed the values given below.

	100 kHz to 1,000 MHz	1,000 MHz to 4,000 MHz
TX. Operating	0.25µW	1 µW
Standby	2 nW	20 nW

4.6 Intermodulation attenuation

This requirement applies only to transmitters to be used in base stations.

4.6.1 Definition

For the purpose of this specification the intermodulation attenuation is a measure of the capability of a transmitter to inhibit the generation of signals in its non-linear elements caused by the presence of the carrier and an interfering signal reaching the transmitter via its antenna.

4.6.2 Method of measurement

The output of the transmitter under test shall be connected to a signal source via a coupling device, presenting to the transmitter a load with an impedance of 50 ohms.

The coupling device can consist of a circulator, one port of which is to be connected by a coaxial cable to the output terminal of the transmitter, the second port is to be correctly terminated (nominal value 50 ohms). This termination is to be provided with means for connection to a selective measuring device (e.g. a spectrum analyser). The third port of the circulator is to be connected to the test signal source by means of an isolator.

Alternatively, the coupling device may consist of a resistive attenuator, which may be combined with an isolator, one end to be connected to the output terminal of the transmitter by coaxial cable and the other end to be connected to the test signal source. A selective measuring device is to be connected to the transmitter end of the attenuator by means of a sampling problem giving the required attenuation.

The transmitter under test and the test signal source shall be physically separated in such a way that the measurement is not influenced by direct radiation. The test signal shall be unmodulated and the frequency shall be within 1-4 neighbouring channels above the frequency of the transmitter under test. The frequency shall be chosen in such a way that the intermodulation components to be measured do not coincide with other spurious emissions. The test signal power level shall be adjusted to -30 dB relative to the carrier power level of the transmitter, both levels being measured at the output of the transmitter. The power level of the test signal shall be measured at the transmitter end of the coaxial cable, when disconnected from the transmitter and then correctly matched (nominal value 50 ohms)[4].

The output power of the transmitter shall be measured directly at the output terminal connected to an artificial antenna (Clause 3.5.).

With the transmitter switched on in an unmodulated condition the levels of the transmitter carrier and the intermodulation components are compared by means of the selective measuring device.

The length of the coaxial cable between the transmitter output and the coupling device shall be varied until the maximum level of the intermodulation component considered is obtained.

This measurement shall be repeated with the test signal at a frequency within 1-4 neighbouring channels below the transmitter frequency.

When the above measurements are performed, precautions must be taken, so that non-linearities in the selective measuring device do not influence the results appreciably. Furthermore it should be ensured that intermodulation components, which may be generated in the test signal source, are sufficiently reduced, e.g. by means of a circulator.

[4] The impedance that the transmitter presents to the test signal being unknown, the test signal level cannot be measured or its amplitude compared with that of the intermodulation components, while the transmitter is connected.

The intermodulation attenuation is expressed as the ratio in dB of the test signal power level to the power level of an intermodulation component.

4.6.3 Limits

The intermodulation attenuation shall be at least 15 dB for any intermodulation component.

Note. For certain special services it may be necessary to have an intermodulation attenuation of at least 40 dB. This may be achieved by means of isolating devices, such as circulators.

5 RECEIVER

5.1 Maximum usable sensitivity

5.1.1 Definition

The maximum usable sensitivity of the receiver is the minimum level of signal (e.m.f.) at the receiver input, at the nominal frequency of the receiver, with normal test modulation (Clause 3.4.), which will produce:

5.1.1.1 in all cases, an audio-frequency output power of at least 50% of the rated power output (Clause 3.3.)

and

5.1.1.2 either a SND/ND ratio[5] of 20 dB, measured at the receiver output through a telephone psophometric weighting network as described in CCITT Recommendation P.53A,

or

5.1.1.3 a SND/N ratio of 20 dB, measured with the psophometric network mentioned in Clause 5.1.1.2.

Note 1. It is considered that these alternatives will give closely similar results. Administrations are requested to state, in their type-approval test reports, which method or methods have been used.
Note 2. It is recognised that the results of measurements based on the definitions given above may differ from those which would be obtained for a SND)/ND ratio of 12 dB in the absence of a psophometric weighting network. However, evidence points to the conclusion that the differences will be small.
Note 3. The characteristics of the 1 kHz band-stop filter used in SND/ND measurements shall be such that at the output the attenuation at 1 kHz will be at least 40 dB and at 2 kHz will not exceed 0.6 dB. The filter characteristic shall be flat within 0.6 dB over the ranges of 20 Hz to 500 Hz and 2 kHz to 4 kHz. In the absence of modulation, the filter must not cause more than 1 dB attenuation of the total noise power at the audio-frequency output of the receiver under test.

5.1.2 Method of measuring the SND/ND ratio

A signal of carrier frequency equal to the nominal frequency of the receiver and with normal test modulation according to Clause 3.4. shall be applied to the receiver input terminals. An audio frequency output load and a distortion factor meter. incorporating a 1 kHz band-stop filter and a psophometric telephone weighting network as mentioned in Clause 5.1.1.2. shall be connected to the receiver output terminals. Where possible, the receiver volume control shall be adjusted to give at least 50% of the rated output power (Clause 3.3.) and, in the case of stepped volume controls, to the first step that provides an output power of at least 50% of the rated output power.
The test signal input level shall be reduced until a SND/ND ratio of 20 dB is obtained. The test signal input level under these conditions is the value of the maximum usable sensitivity. The measurement shall be made under normal test conditions (Clause 2.3.) and extreme test conditions (Clauses 2.4.1. and 2.4.2. applied simultaneously).

Under extreme test conditions. a variation of the receiver output power of ± 3 dB from the value obtained under normal test conditions may be allowed.

[5] S = Signal.
N = Noise.
D = Distortion.

5.1.3 Method of measuring the SND/N ratio

A signal of carrier frequency equal to the nominal frequency of the receiver and with normal test modulation according to Clause 3.4. shall be applied to the receiver input terminals. An audio frequency output load and a psophometric telephone weighting network as mentioned in Clause 5.1.1.2. shall be connected to the receiver output terminals. Where possible, the receiver volume control shall be adjusted to give at least 50% of the rated output power (Clause 3.3.) and, in the case of stepped volume controls, to the first step that provides an output power of at least 50% of the rated output power.
The test signal input level shall be reduced until a SND/N ratio of 20 dB is obtained. (For this measurement the modulation is switched on and off.)
The test signal input level under these conditions is the value of the maximum usable sensitivity. The measurement shall be made under normal test conditions (Clause 2.1.) and extreme test conditions (Clauses 2.4.1. and 2.4.2. applied simultaneously).
Under extreme test conditions, a variation of the receiver output power of ± 3 dB from the value obtained under normal test conditions may be allowed.

5.1.4 Limits

The maximum usable sensitivity shall not exceed + 6 dB relative to an e.m.f. of one microvolt under normal test conditions, and + 12 dB relative to an e.m.f. of one microvolt under extreme test conditions.

5.2 Amplitude characteristic of receiver

5.2.1 Definition

The amplitude characteristic of the receiver is the relationship between the radio frequency input level of a specified modulated signal and the audio-frequency level at the receiver output

5.2.2 Method of measurement

A test signal at the nominal frequency of the receiver, with normal test modulation (Clause 3.4.), at a level of + 6 dB relative to an e.m.f. of one microvolt, shall be applied to the receiver input and the audio output shall be adjusted to give a level of approximately 25% of the rated output power (Clause 3.3.). The input signal shall be increased to + 100 dB relative to an e.m.f. of one microvolt and the level of the audio output shall again be measured.

5.2.3 Limits

For the specified change in radio frequency input level, the change of audio output level shall not exceed 3 dB between the maximum and minimum output levels.

5.3 Co-channel rejection

5.3.1 Definition

The co-channel rejection is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal, both signals being at the nominal frequency of the receiver.

5.3.2 Method of measurement

The two input signals shall be connected to the receiver via a combining network (see also Clause 3.1.). The wanted signal shall have normal test modulation (Clause 3.4.). The unwanted signal shall be modulated with a frequency of 400 Hz with a deviation of 60% of the maximum permissible (Clause 4.3.1.3.). Both input signals shall be at the nominal frequency of the receiver under test and the measurement repeated for displacements of the unwanted signal of up to ± 3,000 Hz.
The amplitude of the wanted input signal (e.m.f.) shall be adjusted to the level of the limit for the maximum usable sensitivity (Clause 5.1.4.). The amplitude of the unwanted input signal shall then be adjusted until either the SND/ND ratio or the SND/N ratio (psophometrically weighted) at the output of the receiver is reduced to 14 dB.

The co-channel rejection ratio shall be expressed as the ratio in dB of the level of the unwanted signal to the level of the wanted signal at the receiver input for which the above-mentioned reduction in SND/ND ratio or SND/N ratio occurs.

5.3.3 Limits

The co-channel rejection ratio at any frequency of the unwanted signal within the specified range shall be greater than:
- 8 dB for channel separations of 20 kHz and 25 kHz,
- 12 dB for a channel separation of 12.5 kHz.

5.4 Adjacent channel selectivity

5.4.1 Definition

The adjacent channel selectivity is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal which differs in frequency from the wanted signal by an amount equal to the adjacent channel separation for which the equipment is intended.

5.4.2 Method of measurement

The two input signals shall be applied to the receiver input via a combining network (see also Clause 3.1.). The wanted signal shall be at the nominal frequency of the receiver and shall have normal test modulation (Clause 3.4.). The unwanted signal shall be modulated by a frequency of 400 Hz with a deviation of 60% of the maximum permissible (Clause 4.3.1.3.) and shall be at the frequency of the channel immediately above that of the wanted signal.
The amplitude of the wanted input signal (e.m.f.) shall be adjusted to the level of the limit for the maximum usable sensitivity (Clause 5.1.4.). The amplitude of the unwanted input signal shall then be adjusted until either the SND/ND ratio or the SND/N ratio at the receiver output, psophometrically weighted, is reduced to 14 dB. The measurement shall be repeated with an unwanted signal at the frequency of the channel below that of the wanted signal. The adjacent channel selectivity shall be expressed as the lower value of the ratios in dB for the upper and lower adjacent channels of the level of the unwanted signal to the level of the wanted signal.
The measurements shall then be repeated under extreme test conditions (Clauses 2.4.1. and 2.4.2. applied simultaneously).

5.4.3 Limits

For channel separations of 20 kHz and 25 kHz, the adjacent channel selectivity shall not be less than 70 dB under normal test conditions and not less than 60 dB under extreme test conditions. For channel separations of 12.5 kHz, the adjacent channel selectivity shall not be less than 60 dB under normal test conditions and not less than 50 dB under extreme test conditions.

5.5 Spurious response rejection

5.5.1 Definition

The spurious response rejection is a measure of the capability of the receiver to discriminate between the wanted modulated signal at the nominal frequency and an unwanted signal at any other frequency at which a response is obtained.

5.5.2 Method of measurement

Two input signals shall be applied to the receiver input via a combining network (see also Clause 3.1.). The wanted signal shall be at the nominal frequency of the receiver and shall have normal test modulation (Clause 3.4.). (The unwanted signal shall be modulated with a frequency of 400 Hz with a deviation of 60% of the maximum permissible deviation (Clause 4.3.1.3.).).
The amplitude (e.m.f.) of the wanted input signal shall be adjusted to the level of the limit for the maximum usable sensitivity (Clause 5.1.). The amplitude of the unwanted input signal shall be adjusted to a level of + 86 dB relative to an e.m.f. of 1 microvolt. The frequency shall then be varied over the frequency range from 100 kHz to 4.000 MHz.
At any frequency at which a response is obtained, the input level shall be adjusted until the SND/ND ratio or SND/N ratio, psophometrically weighted. is reduced to 14 dB.
The spurious response rejection ratio shall be expressed as the ratio in dB between the unwanted signal and the wanted signal at the receiver input when the above-mentioned reduction in the SND/ND ratio or SND/N ratio is obtained.

Note. If the test equipment is not suitable for measuring at frequencies below 10 MHz, a note to this effect shall be made on the test report.

5.5.3 Limits

At any frequency separated from the nominal frequency of the receiver by an amount exceeding one channel separation, the spurious response rejection ratio shall be greater than 70 dB.

5.6 Intermodulation response

5.6.1 Definition

The intermodulation response is a measure of the capability of a receiver to inhibit the generation of in-band signals caused by the presence of two or more signals at unwanted frequencies.

5.6.2 Method of measurement

Two signal generators A and B shall be connected to the receiver via a combining network (see also Clause 3.1.). The signal from signal generator A shall have normal test modulation (Clause 3.4.) and shall be adjusted to a frequency separated by twice the channel separation above (or below) the normal frequency. Signal generator B shall then be switched on. It shall be unmodulated and adjusted to the frequency separated by one channel separation above (or below) the nominal frequency. The output levels of the two signal generators shall be kept equal and increased in level until a SND/ND ratio or a SND/N ratio of 20 dB (psophometrically weighted) is produced at the output of the receiver.
The frequency of signal generator A shall be adjusted slightly, if necessary, to produce the maximum SND/ND ratio or SND/N ratio. The levels of the two test signals shall be readjusted to restore the ratio of 20 dB.
The intermodulation response is equal to the level (e.m.f.) of the two signal generators.
The measurements shall be repeated with frequency separations of up to 4 and 8 times the channel separation.

5.6.3 Limits[6]

The intermodulation response shall not be less than 70 dB relative to an e.m.f. of 1 μV

5.7 Blocking or desensitisation

5.7.1 Definition

Blocking is a change (generally a reduction) in the wanted output power of a receiver or a reduction of the SND/ND ratio or SND/N ratio due to an unwanted signal on another frequency.

5.7.2 Method of measurement

Two input signals shall be applied to the receiver via a combining network (see also Clause 3.l.). The modulated wanted signal shall be at the nominal frequency of the receiver and shall have normal test modulation (Clause 3.4.). Initially the unwanted signal shall be switched off and the input level of the wanted signal adjusted to +6 dB relative to an e.m.f. of one microvolt.
The output power of the wanted signal shall be adjusted, where possible, to 50% of the rated output power (Clause 3.3.) and, in the case of stepped volume controls, to the first step that provides an output power of at least 50% of the rated output power. The unwanted signal shall be unmodulated, and the frequency shall be varied between + 1 MHz and + 10 MHz, and also between -1 MHz and -10 MHz, relative to the nominal frequency of the receiver. The input level of the unwanted signal, at all frequencies in the specified ranges, shall be so adjusted that the unwanted signal causes:
(a) a reduction of 3 dB in the output level of the wanted signal,
or
(b) a reduction to 14 dB of the SND/ND ratio or SND/N ratio at the receiver output (with a psophometric filter),
whichever occurs first.
This input level is the blocking level for the frequency concerned

5.7.3 Limits

The blocking level for any frequency within the specified ranges, shall be not less than +90 dB relative to an e.m.f. of 1 microvolt, except at frequencies on which spurious responses are found (Clause 5.5.).

[6] It is foreseen that this limit will be increased to 76 dB relative to an e.m.f. of 1 μV.

5.8 Spurious emissions

5.8.1 Definition

Spurious emissions are any emissions from the receiver.
The level of spurious emissions shall be measured by:
(a) their power level in a transmission line or antenna and
(b) their effective radiated power when radiated by the cabinet and structure of the equipment;
(b) is also known as "cabinet radiation".

5.8.2 Method of measuring the power level

Spurious emissions shall be measured as the power level of any discrete signal at the input terminals of the receiver. The receiver input terminals are connected to a spectrum analyser or selective voltmeter having an input impedance of *50* ohms and the receiver is switched on.
If the detecting device is not calibrated in terms of power input, the level of any detected components shall be determined by a substitution method using a signal generator.
The measurements shall extend over a frequency range of 100 kHz to 4.000 MHz.

5.8.3 Method of measuring the effective radiated power

On a test site fulfilling the requirements of Clause 3.7., the sample shall be placed at the specified height on a non-conducting support. The receiver shall be operated from a power source via a radio frequency filter to avoid radiation from the power leads.
Radiation of any spurious components shall be detected by the test antenna and receiver over the frequency range 30-4.000 MHz.
At each frequency at which a component is detected, the sample shall be rotated to obtain maximum response and the effective radiated power of that component determined by a substitution measurement.
The measurements shall be repeated with the test antenna in the orthogonal polarisation plane.

5.8.4 Limit

The power of any spurious emission in the range 100 kHz to 1.000 MHz shall not exceed 2 nanowatts, and in the range 1.000 MHz to 4.000 MHz shall not exceed 20 nanowatts.

6 DUPLEX OPERATION

If the equipment is designed for duplex operation, when submitted for type testing it shall be fitted with a duplex filter and the following additional measurements shall be carried out to ensure satisfactory duplex operation.

6.1 Receiver desensitisation with simultaneous transmission and reception

6.1.1 Definition

The desensitisation is the degradation of the sensitivity of the receiver resulting from the transfer of power from the transmitter to the receiver due to coupling effects. It is expressed as the difference in dB of the maximum usable sensitivity levels with simultaneous transmission and without.

6.1.2 Method of measurement when the equipment has a duplex filter

The transmitter and the receiver are connected to the duplex filter, the antenna terminals being connected through a coupling device to the artificial antenna specified in Clause 3.5. A signal generator with normal test modulation (Clause 3.4.) is connected to the coupling device so that it does not affect the impedance matching. The transmitter is brought into operation at the carrier output power as defined in Clause 4.2., modulated at 400 Hz with a deviation of 60% of the maximum permissible (Clause 4.3.1.).
The receiver sensitivity is then measured in accordance with Clause 5. 1.
The output level of the signal generator is recorded as C in dB relative to µV e.m.f.
The transmitter is switched off and the receiver sensitivity is again measured.
The output level of the signal generator is recorded as D in dB relative to an e.m.f of 1 microvolt.
The desensitisation is the difference between the values of C and D.

6.1.3 Measuring method when the equipment has to operate with two antennae

The transmitter is connected to an attenuator to dissipate the nominal HF output power of the transmitter, the rating of which is declared by the manufacturer. The attenuator output is connected to the receiver input by means of a coupling device and a filter if the latter is part of the standard equipment. The total attenuation between transmitter and receiver is 30 dB. A signal generator with normal test modulation (Clause 3.4.) is connected to the coupling device in such a way as not to affect the impedance matching. The transmitter is brought into operation with an output power as defined in Clause 4.2.; it is modulated at 400 Hz with a frequency deviation of 60% of the maximum permissible frequency deviation (Clause 4.3.1.).
The receiver sensitivity is then measured in accordance with Clause 5. 1.
The output level of the signal generator is recorded as C in dB relative to 1 μV e.m.f.
This transmitter is then switched off and the receiver sensitivity is measured again.
The output level of the signal generator is recorded as D in dB relative to 1 μV e.m.f.
The desensitisation is the difference between the values of C and D.

6.1.4 Limit

The desensitisation shall not exceed 3 dB. The maximum usable sensitivity under conditions of simultaneous transmission and reception shall not exceed the limits specified in Clause 5.1.4.

6.2 Receiver spurious response rejection

The receiver spurious response rejection is measured as specified in Clause 5.5. with the equipment arrangement described in Clause 6.1., except that the transmitter shall be unmodulated. The transmitter shall be operated at the carrier output power as defined in Clause 4.2.
The limit given in Clause 5.5.3. applies.

7 PRESENTATION OF SINGLE AND MULTICHANNEL EQUIPMENT FOR TYPE APPROVAL

7.1 Choice of model for type approval

The manufacturer shall provide a production model of the equipment, for type-approval testing. If type approval is given on the basis of tests on a preliminary model, then the corresponding production models must be identical in all respects with the preliminary model tested.

7.2 Single-channel equipment

Any channel within the specified frequency range may be selected for type approval testing. The choice shall be approved by the testing authority.

7.3 Multichannel equipment

Type-approval tests need to be carried out only on the highest and lowest channels within the switching range of the equipment and on a channel near the middle of the switching range, except in special circumstances. The switching range shall be declared by the manufacturer. The choice of channels for type-approval testing shall be approved by the testing authority.

8 ACCURACY OF MEASUREMENTS

The tolerance for the measurement of the following parameters shall be as given below:

8.1.1.	DC voltage	± 3%
8.1.2.	AC mains voltage	± 3%
8.1.3.	AC mains frequency	± 0.5%
8.2.1.	Audio-frequency voltage, power, etc.	± 0.5 dB
8.2.2.	Audio frequency	± 1 %
8.2.3.	Distortion and noise, etc. of audio-frequency generators	1%
9.3.1.	Radio frequency carrier power	± 50 Hz
8.3.2.	Radio-frequency voltage	± 2 dB
8.3.	Radio-frequency field strength	± 3 dB
8.3.4.	Radio-frequency carrier power	± 10%
9.3.5.	Adjacent channel power	± 3 dB
8.4.1.	Impedance of artificial loads, combining units, cables, plugs, attenuators, etc.	± 5%
8.4.2.	Source impedance of generators and input impedance of measuring receivers	± 10%
8.4.3.	Attenuation of attenuators	± 0.5 dB
8.5.1.	Temperature	± 1° C
8.5.2.	Humidity	± 5%

Appendix A

GUIDANCE ON THE USE OF RADIATION TEST SITES

For measurements involving the use of radiated fields. use may be made of a test site in conformity with the requirements of paragraph 3.7. of the Annex. When using such a test site, the following conditions should be observed to ensure consistency of measuring results.

1. Measuring Distance

Evidence indicates that the measuring distance is not critical and does not significantly affect the measuring results, provided that the distance is not less than $\lambda/2$ at the frequency of measurement, and the precautions described in this Annex are observed.

Measuring distances of 3 m, 5 m, 10 m and 30 m are in common use in the CEPT countries.

2. Test Antenna

Different types of test antenna may be used, since in performing substitution measurements, calibration errors of the test antenna do not affect the measuring results.

Height variation of the test antenna over a range of 1-4 metres is essential in order to find the point at which the radiation is a maximum.

Height variation of the test antenna may not be necessary at the lower frequencies below about 100 MHz.

3. Substitution Antenna

Variations in the measuring results may occur with the use of different types of substitution antenna at the lower frequencies below about 80 MHz. Where a shortened dipole antenna is used at those frequencies, details of the type of antenna used should be included with the results of the tests carried out on the site.

4. Artificial Antenna

The dimensions of the artificial antenna used during case radiation measurements should be small in relation to the sample under test.

Where possible, a direct connection should be used between the artificial antenna and the test sample.

In cases where it is necessary to use a connecting cable, means should be taken to reduce the radiation from this cable by, for example, the use of ferrite cores.

5. Auxiliary Cables

The position of auxiliary cables which are not adequately decoupled may cause variations in the measuring results. In order to get reproducible results, cables and wires of auxiliaries are mounted vertically downwards (through a hole in isolating table or in the base plate of the salt water column), and shall be fitted in their upper part with a radio frequency stop filter (by means, for example, of ferrite tubes).

Annex II

Technical Characteristics of Radio Equipment in the Land Mobile Service with regard to Quality and Stability of Transmission

Note. Text approved by Telecommunications Commission at Puerto de la Cruz and Stockholm (1976).

Table of Contents

1 SCOPE OF THE SPECIFICATIONS

The specifications of “Technical characteristics and test conditions for radio equipment in the land mobile service” (Annex I) are intended to ensure the optimum utilisation of the frequency spectrum by limiting the extent of radio interference.
This series of specifications should be consulted in conjunction with Annex I; it covers the quality and stability of transmission.
Two types of modulation are considered phase and frequency modulation. To ensure compatibility, transmitters and receivers operating in the same network must use the same type of modulation.

2 GENERAL CONDITIONS

2.1 References

References to clauses are to the clauses of Annex L unless otherwise indicated.

2.2 Impedances

All the radio-frequency and audio-frequency input and output impedance values of the equipment shall be fixed by mutual agreement of the manufacturer and the testing authority.

2.3 Audio-frequency output power

For the purposes of these specifications. the nominal audio-frequency output power of the receiver, as declared by the manufacturer, must be adequate to allow its use in real environmental conditions and should not in any case be less than 200 milliwatts at the loud-speaker *(Note 1)* and 1 milliwatt at the ear-piece of the hand-set *(Note 2).*
Notes.
1) Considerably greater output power is required for use in a noisy environment.
2) For a transitional period which shall be determined by each Administration a power level hereof only 70 microwatts shall be acceptable.
Administrations are requested to state the value used in their type-approval test reports.

3 LIMITATION CHARACTERISTIC OF THE TRANSMITTER MODULATOR

3.1 Definition

This characteristic expresses the capability of the transmitter to tie modulated with a frequency deviation approaching the maximum permissible deviation specified in Clause 4.3.1.3

3.2 Method of measurement

A modulating signal with a frequency of 1.000 Hz shall be applied to the transmitter. The level (electromotive force) shall be adjusted to produce a frequency deviation equal to 20% of the maximum permissible deviation specified in Clause 4.3.1.3. The level of the modulating signal shall then be raised 20 dB and the deviation measured again.
This test shall be carried out under normal test conditions (Clause 2.3) and under extreme test conditions (Clauses 2.4. 1. and 2.4.2 applied simultaneously).

3.3 Limits

The frequency deviation should be between 70% and 100% of the maximum permissible deviation.

4 SENSITIVITY OF THE MODULATOR, INCLUDING MICROPHONE

4.1 Definition

This characteristic expresses the capability of the transmitter to be satisfactorily modulated when an audio-frequency signal corresponding to the average normal speech level is applied to the microphone.

4.2 Method of measurement

An audio-frequency signal of 1,000 Hz shall be applied to the microphone, the loudness level at the diaphragm of the microphone being 94 dB/2 x 10‘ Pascal. The deviation produced shall be measured.
Note. Any controls which permit the sensitivity of the modulator to be adjusted should not be accessible to the user.

4.3 Limits

The deviation should be between 60% and 90% of the maximum permissible deviation specified in Clause 4.3.1.3.

5 AUDIO-FREQUENCY RESPONSE OF THE TRANSMITTER

5.1. Definition

The audio-frequency response of the transmitter expresses the capability of the transmitter to operate without excessive degradation of the frequency response as a function of the modulation frequency.

5.2. Methods

Two methods of measurement may be used, which give very similar results. Member Administrations of the CEPT are requested to specify in their type-approval test reports which method or methods have been used.

5.2.1. *Constant deviation method*

A modulating signal with a frequency of 1,000 Hz shall be applied to the transmitter. The level (electromotive force) shall be adjusted to produce a frequency deviation equal to 20% of the maximum permissible deviation specified in Clause 4.3.1.3.
The modulating frequency shall then be varied between 300 Hz and 3.000 Hz (300 Hz and 2,550 Hz for transmitters with adjacent channel separation of 12.5 kHz) and the level of the modulating signal adjusted to produce a constant frequency deviation of the radio-frequency signal of the transmitter equal to the value established above.

5.2.1.1. Phase modulation

For a transmitter utilising a pre-emphasis of 6 dB per octave the characteristic giving the amplitude of the audio-frequency modulating signal as a function of the frequency shall vary within the limits specified below in Clause 5.3.1.1. of Annex II, by 6 dB per octave from the 1.000 Hz point described above, the amplitude decreasing as the frequency is increased.

5.2.1.2. Frequency modulation

For a transmitter using a constant frequency deviation the amplitude of the audio-frequency modulating signal shall remain constant and equal to its value at 1.000 Hz (as above) as the frequency is varied.

5.2.2. *Constant input level method*

A modulating signal with a frequency of 1,000 Hz shall be applied to the transmitter. The level (electromotive force) shall be adjusted to produce a frequency deviation equal to 20% of the maximum permissible deviation specified in Clause 4.3.1.3.

The modulating frequency shall then be varied between 300 Hz and 3.000 Hz (300 Hz and 2,550 Hz for transmitters with adjacent channel separation of 12.5 kHz), the level of the audio-frequency signal being maintained constant and equal to the value above.

5.3. **Limits**

5.3.1. *Constant deviation method*

5.3.1.1. Phase modulation

The amplitude of the audio-frequency modulation signal should not vary from the characteristic given in Clause 5.2.1.1. of Annex II by more than - 1 dB or + 3 dB.

5.3.1.2. Frequency modulation

The amplitude of the audio-frequency modulation signal should not vary by more than - 1 dB or + 3 dB with respect to its value at 1.000 Hz.

5.3.2 Constant input level method

5.3.2.1. Phase modulation

The modulation index (the ratio of the frequency deviation to the modulation frequency) should remain constant and equal to its value at 1.000 Hz within the limits of + 1 dB or - 3 dB.

5.3.2.2. Frequency modulation

The frequency deviation should remain constant and equal to its value at 1,000 Hz within the limits of +1 dB or -3 dB.

6. HARMONIC DISTORTION RATIO OF THE EMISSION

6.1. **Definition**

The harmonic distortion ratio of the transmitter when modulated with an audio-frequency signal is defined as the ratio, expressed as a percentage, of the rms voltage of all the harmonic components of the fundamental audio frequency to the total rms voltage of the signal after linear demodulation.

In the method described below using a distortion meter, the distortion measured includes the components attributable to hum and noise.

6.2. **Method of measurement**

6.2.1. *Phase modulation*

The radio-frequency signal produced by the transmitter shall be applied by means of an appropriate coupling device to a linear demodulator equipped with a de-emphasis network of 6 dB per octave.

Under normal test conditions (Clause 2.3), this radio-frequency signal shall be modulated successively at frequencies of 300 Hz, 500 Hz and 1.000 Hz maintaining a constant modulation index (the modulation index is the ratio of the frequency deviation to the modulation frequency) which at 1.000 Hz produces 60% of the maximum permissible deviation (specified in Clause 4.3.1.3).

The harmonic distortion of the audio-frequency signal shall be measured at each of the frequencies specified above.

Under extreme test conditions (Clauses 2.4.1. and 2.4.2. applied simultaneously), the measurements shall be made at 1,000 Hz with the frequency deviation equal to 70% of the maximum permissible deviation (Clause 4.3.1.3).

6.2.2. *Frequency modulation*

The radio-frequency signal produced by the transmitter shall be applied by means of an appropriate coupling device to a linear demodulator.

Under normal test conditions (Clause 2.3.), the radio-frequency signal shall be modulated successively at 300 Hz, 500 Hz and 1.000 Hz with a frequency deviation equal to 60% of the maximum permissible deviation (Clause 4.3.1.3.). The frequency deviation shall be maintained constant at that value. The harmonic distortion of the audio-frequency signal shall be measured at each of the frequencies specified above.

Under extreme test conditions (Clauses 2.4. 1. and 2.4.2. applied simultaneously), the measurements shall be made at 1.000 Hz with a frequency deviation equal to 70% of the maximum permissible deviation (Clause 4.3.1.3).

6.3. Limits

The harmonic distortion ratio should not exceed 10%.

7. RESIDUAL MODULATION OF THE TRANSMITTER

7.1. Definition

The residual modulation of the transmitter is the ratio, expressed in dB, of the audio-frequency noise power produced after the demodulation of the radio-frequency signal in the absence of any modulation with the wanted signal, by parasitic emissions from the power source, by the modulator or by any other source, to the audio-frequency power produced by the application of the normal test modulation to the transmitter.

7.2. Method of measurement

The normal test modulation, described in Clause 3.4., shall be applied to the transmitter. The high-frequency signal produced by the transmitter shall be applied by means of an appropriate coupling device to a linear demodulator.
For phase modulation the demodulator shall be equipped with a de-emphasis network of 6 dB per octave.
Every precaution must be taken to ensure that the measurements are not falsified by the emphasis of the internal noise of the linear demodulator at low audio frequencies.
The signal shall be measured at the demodulator output with an rms voltmeter equipped with a psophometric filtering network such as described in CCITT Recommendation P.53.
The modulation shall then be switched off and the residual audio-frequency signal at the output terminal measured.

7.3. Limits

Residual modulation should not exceed -40 dB.

8. AUDIO-FREQUENCY RESPONSE OF THE RECEIVER

8.1. Definition

The receiver response expresses the variations in the audio-frequency output level of the receiver as a function of the modulation frequency of the high-frequency input signal.

8.2. Method of measurement

A test signal of 60 d13/1 microvolt electromotive force at the same frequency as the nominal frequency of the receiver shall be applied to the input of the receiver. respecting the conditions specified in Clause 3.1.

The receiver’s audio-frequency power control must be adjusted to provide a power level not less than 50% of the nominal output power (Clause 2.3., Annex II) when the normal test modulation is applied in accordance with Clause 3.4. This setting shall not be altered again during the course of this test.
The frequency deviation at 1000 Hz shall then be reduced to 20% of the maximum permissible deviation. The deviation shall be maintained constant while the modulation frequency is varied between 300 Hz and 3,000 Hz (300 Hz and 2,550 Hz for receivers with adjacent channel separation of 12.5 kHz).
The procedure shall be repeated with a test signal at the same frequency as the nominal frequency of the receiver plus or minus half the absolute frequency tolerance value for the corresponding transmitter given by Table I of Clause 4.1.3

8.3. Limits

8.3.1. *Phase modulation*

For a receiver having a de-emphasis of 6 dB per octave, the characteristic giving the amplitude of the audio-frequency output level varies by 6 dB per octave from the 1,000 Hz point described above, the amplitude decreasing as the frequency is increased.

The audio-frequency output level of the receiver should not vary from this characteristic by more than +1 dB or -3 dB.

8.3.2. *Frequency modulation*

The audio-frequency output level for the reception of constant frequency deviation transmissions should remain equal to its value at 1,000 Hz as the frequency is varied, within the following limits.
The audio-frequency output level of the receiver should remain within + 1 dB or -3 dB of its value at 1.000 Hz.

9. HARMONIC DISTORTION

9.1. Definition

The harmonic distortion ratio at the receiver output is defined as the ratio; expressed as a percentage, of the rms voltage of all the harmonic components of the fundamental audio frequency to the total rms voltage of the signal delivered by the receiver.
In the method of measurement described below, using a distortion meter, the components attributable to hum and noise are included in the distortion measurement.

9.2. Methods of measurement

Test signals of 60 dB/1 microvolt and 100 dB/1 microvolt electromotive force at the same frequency as the nominal frequency of the receiver shall be applied in succession to the input of the receiver, respecting the conditions specified in Clause 3.1.
For each test the receiver’s audio-frequency power control must be adjusted so as to obtain the nominal output power (Clause 2.3, Annex II) for a resistive load which simulates the receiver’s operating load. In the case of a stepped power control it must be set at the first position which gives an output power level not lower than the nominal output power.

9.2.1. *Phase modulation*

Under normal conditions the test signal shall be modulated successively at 300 Hz, 500 Hz and 1.000 Hz maintaining a constant modulation index (ratio of frequency). For a modulation frequency of 1,000 Hz the modulation index must give a frequency deviation to modulation frequency deviation which is 60% of the maximum permissible deviation (Clause 4.3.1.3).
The harmonic distortion shall be measured at each of the above frequencies.
Under extreme test conditions (Clauses 2.4. 1. and 2.4.2. applied simultaneously) the tests shall be made at the receiver’s nominal frequency and at the nominal frequency plus and minus half the absolute value of the frequency tolerance for the corresponding transmitter (given by Table I of Clause 4.1.3).
The modulation frequency for these tests shall be 1.000 Hz and the frequency deviation equal to 70% of the maximum permissible deviation.

9.2.2. *Frequency modulation*

Under normal conditions the test signal shall be modulated successively at 300 Hz, 500 Hz and 1.000 Hz with a frequency deviation equal to 60% of the maximum permissible deviation (Clause 4.3.1.3.).
The harmonic distortion shall be measured at each of the above frequencies.

Under extreme test conditions (Clauses 2.4. 1. and 2.4.2. applied simultaneously) the tests shall be made at the receiver's nominal frequency and at the nominal frequency plus and minus half the absolute value of the frequency tolerance for the corresponding transmitter (given by Table I of Clause 4.1.3).
The modulation frequency for these tests shall be 1.000 Hz and the frequency deviation equal to 70% of the maximum permissible deviation.

9.3. Limits

The harmonic distortion at each audio frequency and under all the test conditions should not exceed 10%.

10. RECEIVER "HUM AND NOISE"

10.1. Definition

The "hum and noise" of the receiver is the ratio, expressed in dB, of the audio-frequency power of the noise and hum produced by the parasitic emissions of the power source or by any other source to the audio-frequency power of a high-frequency signal modulated by the normal test modulation applied at the receiver input.

10.2. Method of measurement

A test signal of 30 dB/1 microvolt electromotive force whose carrier frequency is the same as the nominal frequency of the receiver, modulated by the normal test modulation specified by Clause 3.4., shall be applied to the input of the receiver. An audio-frequency load and a psophometric filtering network (Clause 5.1.1.2.) shall be connected to the output terminals of the receiver. If the audio-frequency power control is of a continuous type, it shall be set to supply not less than the nominal output power (Clause 2.3, Annex II) and, in the case of a stepped power control, set to the first position which gives a power level not lower than the nominal power.
The output signal shall be measured using an rms voltmeter.
The modulation shall then be switched off and the audio-frequency output level measured again.

10.3. Limits

The ratio of the "hum and noise" level of the receiver to the level of the modulation signal should not exceed -40 dB.

11. EXTENDED USAGE TESTS

11.1. Equipment intended for simultaneous transmission and reception (duplex) with or without a duplex filter

The characteristics specified in the clause below shall be satisfied:
- after a period of 24 hours on standby followed by:
- 4 thirty-minute transmission periods separated by five-minute standby periods.

11.2. Equipment intended for alternating operation (simplex)

The characteristics specified in the clause below shall be satisfied:
- after a period of 24 hours on standby followed by:
- 8 three-minute transmission periods separated by fifteen-minute standby periods.

11.3. Specified requirements

The operation of the equipment shall be checked to verify that the technical requirements of Clauses 4. and 5. of Annex I and the technical requirements of Annex II are satisfied.

Annex III

Technical characteristics and test conditions for radio equipment using integral antennas in the land-mobile service

Note. Text approved by Telecommunications Commission at Stockholm (1977). Vienna (1982). Cannes (1983) and Copenhagen (1987)

Table of contents

1. SCOPE OF THE SPECIFICATIONS

These technical specifications cover the minimum characteristics considered necessary in order to make the best use of the available frequencies. It does not necessarily include all the characteristics, which may be required by a user, nor does it necessarily represent the optimum performance achievable. It applies to equipment with integral antennas employed in frequency modulation and phase modulation systems as chosen by each CEPT Administration for the land mobile service, operating on radio frequencies between 30 MHz and 1,000 MHz. which channel separations of 12.5 kHz, 20 kHz, or 25 kHz.
Additional specifications or amendments are required for equipment such as:

- for transmission of signals other than speech (see Annex V and VI to this Recommendation);

Additional specifications or amendments may be required for equipment such as that:

- intended for connection to the public switched telephone networks;
- using other types of modulation;

In the specifications different requirements are given for the different radio frequency bands, channel separations. Etc., where appropriate.
In this specification, an integral antenna is defined as one which is designed to be connected permanently to the transmitter or receiver without the use of an external feeder or connector.

There will be two categories of radio equipment using integral antennas:

Category A: Equipment which for frequency planning purposes can be considered compatible with the type of equipment specified in Annex 1, and therefore has to meet similar technical requirements.

Category B: Equipment with reduced performance compared to category A equipment because of design restrictions on size and weight (normally the length of the integral antenna would not exceed the greatest dimension of the equipment). The necessary reduced power consumption and consequent coverage range may require this equipment to be considered separately from category, A equipment for frequency planning purposes.

For equipment, which also includes an antenna socket for use with external antennas, this equipment shall be type tested in accordance with the requirements of Annex I using this socket.

2. PRESENTATION OF SINGLE AND MULTICHANNEL EQUIPMENT FOR TYPE APPROVAL

2.1. Choice of model for type approval

The manufacturer shall provide a production model of the equipment for type approval testing. If type approval is given on the basis of tests on a preliminary model, then the corresponding production models must be identical in all respects with the preliminary model tested.

2.2. Single-channel equipment

Any channel within the specified frequency range may be selected for type approval testing. The choice shall be approved by the testing authority.

2.1. Multichannel equipment

Type approval tests need only be carried out on the highest and lowest channels within the switching range of the equipment and on a channel near the middle of the switching range, except in special circumstances. The switching range shall be declared by the manufacturer. The choice of channels for type approval testing shall be approved by the testing authority.

3. MECHANICAL AND ELECTRICAL DESIGN

3.1. General

The equipment shall be constructed in accordance with good and prevalent engineering practice.

3.2. **Controls**
Those controls, which if maladjusted might increase the interfering potentialities of the equipment, shall not be easily accessible to the user.

3.3. **Integral antenna**
The type approval of equipment with integral antennas only applies to that equipment together with the antennas originally provided by the manufacturer for type testing.

3.4. **Synthesisers and PLL-systems**
If, for generating the transmitter frequency, use is made of a frequency synthesiser and/or a phase locked loop system, the transmission shall be inhibited when synchronisation is absent.

3.5 **Labelling**
The equipment shall be provided with a clear indication of the manufacturer and/or the trade mark, type designation, serial number and the type approval mark. All indications mentioned above shall be fitted on the outside of the equipment, shall be clearly readable, unremovable and indelible

4. **TEST CONDITIONS, POWER SOURCES AND AMBIENT TEMPERATURES**

4.1. **Normal and extreme test conditions**
Type approval tests shall be made under normal test conditions, and also, where stated. under extreme test conditions.
The test conditions and procedures shall be as specified in Clauses 4.2. to 4.5.

4.2 **Test power source**
During type approval tests the power source of the equipment shall be replaced by a test power source, capable of producing normal and extreme test voltages as specified in Clauses 4.3.2. and 4.4.2. The internal impedance of the test power source shall be low enough for its effect on the test results to be negligible. For the purpose of tests, the voltage of the power source shall be measured at the input terminals of the equipment.
In equipment with incorporated batteries the test power source shall be applied as close to the battery terminals as practicable.
During tests, the power source voltages shall be maintained within a tolerance of ±3% relative to the voltage at the beginning of each test.

4.3. **Normal test conditions**

4.3.1. *Normal temperature and humidity*
The normal temperature and humidity conditions for tests shall be any convenient combination of temperature and humidity within the following ranges:
Temperature: + 15° C to + 35° C
Relative humidity: 20% to 75%
Note. When it is impracticable to carry out the tests under these conditions. a statement giving the actual temperature and relative humidity during the test, shall be added to the test report.

4.3.2. *Normal test power source*
The normal test power source voltage shall be the nominal voltage as declared by the equipment manufacturer.

4.4. **Extreme test conditions**

4.4.1. *Extreme temperatures*
For tests at extreme temperatures. measurements shall be made in accordance with the procedures specified in Clause 4.5., at the upper and lower temperatures of one of the following ranges:
- 25° C to + 55° C
- 10° C to + 55° C
Type approval test reports should state which range is applicable.

4.4.2. *Extreme test source voltages*

The lower extreme test voltage for equipment with power sources using batteries shall be as follows:

1. for the Leclanch6 or the lithium-type of battery:
   0.85 times the nominal voltage of the battery:
2. for the mercury-type or nickel- cadmium- type of battery:
   0.9 times the nominal voltage of the battery;
3. for other types of batteries:
   end point voltage declared by the equipment manufacturer.

For equipment using other power sources, or capable of being operated from a variety of power sources, the extreme test voltages shall be those agreed between the equipment manufacturer and the testing authority and shall be recorded with the results.

4.5. **Procedure for tests at extreme temperatures**

Before measurements are made the equipment shall have reached thermal balance in the test chamber. The equipment shall be switched off during the temperature stabilising period. If the thermal balance is not checked by measurements, a temperature stabilising period of at least one hour, or such period as may be decided by the testing authority, shall be allowed. The sequence of measurements shall be chosen, and the humidity content in the test chamber shall be controlled so that excessive condensation does not occur.

Before tests at the upper temperature the equipment shall be placed in the test chamber and kept until thermal balance is attained. The equipment shall then be switched on for one minute in the transmit condition, followed by four minutes in the receive condition, after which the equipment shall meet the specified requirements.

For tests at the lower temperatures the equipment shall be left in the test chamber until thermal balance is attained, then switched to the stand-by or receive condition for a period of one minute after which the equipment shall meet the specified requirements.

5. GENERAL CONDITIONS

5.1. **Arrangements for test signals applied to the receiver via a test fixture or a test antenna**

Sources of test signals for application to the receiver via a test fixture (Clause 5.7.), a stripline (Clause 5.8.) or a test antenna (Clause 5.9.) shall be connected in such a way that the impedance presented to the test fixture. the stripline or the test antenna is 50 ohms.

This requirement shall be met irrespective of whether one or more signals are applied to the receiver simultaneously.

The effects of arty intermodulation products and noise produced in the signal generators should be negligible.

5.2. **Receiver mute or squelch facility**

The receiver mute or squelch circuit shall be made inoperative for the duration of the type approval tests, except for the tests contained in Clauses 7.1. and 7.5.

5.3. **Acoustic measuring arrangement**

5.3.1. *General considerations*

For measurements on the test site or in the stripline additional electrical connections shall not be used because of their influence on the RF-performance of the equipment under test.

Measurements of the output signal-to-noise ratio of a receiver will be made by means of acoustic coupling to a microphone. On a radiation test site all conducting materials used in the measuring equipment will be placed below the ground surface and the acoustic energy is conveyed from the receiver to the microphone by means of a non-conducting acoustic pipe. When a stripline (Clause 5.8.) is used. the same measuring arrangement may be used placing the microphone outside the RF-field of the stripline.

5.3.2. Acoustic coupling arrangement

The acoustic pipe shall be long enough (e.g. *2* m) to reach from the equipment under test to the microphone. The acoustic pipe shall have an inner diameter of *6* mm and a wall thickness of about 1.5 mm. A plastic funnel having a diameter appropriate to the size of the loudspeaker in the equipment under test, with soft form rubber glued to its edge, shall be fitted to one end of the acoustic pipe and the microphone shall be fitted to the other end.

5.3.3. Acoustic lest fixture

It is very important to fix the centre of the funnel in a reproducible position relative to the equipment under test, since the position of the centre has a strong influence on the frequency response that will be measured. This can be achieved by placing the equipment in a close fitting acoustic test fixture, supplied by the manufacturer, of which the funnel is an integral part.

5.3.4. Method of measurement

When an acoustic measuring arrangement is used the measured signal-to-noise ratio will be a function of the response characteristics of the audio amplifier. the internal speaker and the specified test fixture or acoustic measuring arrangement. In this specification parameter measurements that are made by using acoustic coupling must give the same results as though direct electrical connections were made across the speaker terminals. This is accomplished by using the acoustic SND/ND or SND/N instead of the normal SND/ND or SND/N in the methods of measurements.

In this specification the normal signal-to-noise ratio is 20 dB SND/ND or SND/N. Acoustic SND/ND or SND/N is the signal-to-noise ratio of an acoustic signal which is produced by an acoustic transducer (loudspeaker) when the SNID/ND or SND/N measured by direct electrical connection is 20 d B. The acoustic SND/ND or SND/N may be several dB greater or less than 20 dB.

It should be noted that the manufacturer can open the receiver to make a direct electrical connection across the speaker (or output of the audio amplifier) and determine in the laboratory the acoustic SND/ND or SND/N which is equivalent to the 20 dB SND/ND or SND/N measured with direct connection to the transducer, using an acoustic test fixture with an acoustic tube of 2 m length. microphone and correcting network, identical to the one used on the test site (Clause 5.9.) or in the stripline arrangement (Clause 5.8.).

After the acoustic SND/ND or SND/N has been determined, all measurements made on the receiver in its specified test fixture or on the radiation test site use the acoustic SND/ND or SND/N value whenever the normal signal-to-noise ratio is required.

5.4. **Receiver rated audio output power**

The rated audio output power shall be the maximum power, declared by the manufacturer. for which all the requirements of this specifications are met. With normal test modulation (Clause 5.5.), the autio output power shall be measured in a resistive load. simulating the load with which the receiver normally operates. The value of this load shall be declared by the manufacturer.

5.5. **Normal test modulation**

The frequency of the normal test modulation shall be 1 kHz and the resulting frequency deviation shall be 60% of the maximum permissible frequency deviation (Clause 6.3.1.). The test signal shall be substantially free from amplitude modulation.

5.6. **Transmitter artificial antenna**

Tests on the transmitter requiring the use of the test fixture shall be carried out with a 50 ohms substantially non-reactive non-radiating load connected to the test fixture terminal.

5.7. **Tests fixture**

The manufacturer may be required to supply a test fixture suitable to allow relative measurements to be made on the submitted sample.

The testing authority may also provide its own test fixture.

The test fixture shall provide a 50 ohms radio frequency terminal at the working frequencies of the equipment.

The test fixture shall provide means of making external connection to the audio frequency input and output and of replacing the power source by external power supplies. The performance characteristics of the test fixture under normal and extreme conditions are subject to the approval of the testing authority.
The characteristics of interest to the testing authority will the following:
(a) the coupling loss shall not be greater than 30 dB;
(b) the variation of coupling loss with respect to frequency shall not cause errors exceeding 2 dB in measurements using the test fixture;
(c) the coupling device shall not include any non-linear elements.

5.8. **Strip line arrangement**

The strip line arrangement can be used as a substitute for the test site described in Clause 5.9. for the measurements described in Clauses 6.5., 7.l., 7.5. and 7.7. The useful frequency range should be at least 1 MHz to 4 GHz.

The strip line must be constructed in such a way, that in the middle part of the strip line where the equipment under test will be mounted a homogenous electromagnetic field of a known strength can be generated or received.

5.9. **Test site and general arrangements for measurements involving the use of radiated fields**
(For general guidance see also Appendix A.)

5.9.1. *Test site*

The test site shall be on a reasonably level surface or ground. A ground plane of at least 5 metres diameter shall be provided on the site. In the middle of this ground plane, a support, capable of rotation through 360 in the horizontal plane, shall be used to support the test sample at 1.5 metres above the ground plane.
Equipment which is not intended to be worn on a person. including hand-held equipment, shall be tested using a non-conducting support.
Equipment which is intended to be worn on a person shall be tested using a simulated-man test fixture as support.
The simulated-man test fixture comprises a container filled with salt water.

The container shall have the following dimensions:

- Height	1.7 ± 0.1 mm
- Inside diameter	300 ± 5 mm
- Sidewall thickness	5 ± 0.5 mm

The container shall be filled with a salt (NaC1) solution of 1.49 g per litre of distilled water.

The test site shall be large enough to allow the erection of a measuring or transmitting antenna at a distance of at least the highest of the two values $\lambda/2$ and 3 m. The distance actually used shall be recorded with the results of the test carried our on the site. Sufficient precautions shall be taken to ensure that reflections from extraneous objects adjacent to the site and ground reflections do not degrade the measurement results.

5.9.2. *Test antenna*

When the site is used for radiation measurements the test antenna is used to detect the radiation from both the test sample and the substitution antenna. When the site is used for the measurement of receiver characteristics the antenna is used as a transmitting antenna. This antenna is mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarisation and for the height of its centre above ground to be varied over the range 1-4 metres. Preferably test antennas with pronounced directivity should be used. The size of the test antenna alone the measurement axis shall not exceed 20% of the measuring distance. For radiation measurements, the test antenna is connected to a test receiver, capable of being tuned to any frequency under investigation and to measure accurately the relative levels of signals at its input. For receiver measurements the test receiver is replaced by a signal source.

5.9.3 *Substitution antenna*

When measuring in the frequency range up to 1 GHz the substitution antenna shall be a $\lambda/2$ dipole, resonant at the frequency under consideration, or a shortened dipole. calibrated to the $\lambda/2$ dipole. When measuring in the frequency range above 4 GHz a horn radiator shall be used. For measurements between 1 and 4 GHz either a $\lambda/2$ dipole or a horn radiator may be used. The centre of this antenna shall coincide with the reference point of the test sample it has replaced. This reference point shall be the volume centre of the sample when its antenna is mounted inside the cabinet, or the point where an outside antenna is connected to the cabinet.

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The distance between the lower extremity of the dipole and the ground shall be at least 30 cm. The substitution antenna shall be connected to a calibrated signal generator when the site is used for radiation measurements and to a calibrated measuring receiver when the site is used for measurement of receiver characteristics. The signal generator and the receiver shall be operating at the frequencies under investigation and shall be connected to the antenna through suitable matching and balancing networks.

5.9.4. *Optional additional indoor site*

For measurements when the frequency of the signals being measured is greater than 80 MHz, use may be made of an indoor site. If this alternative site is used, this shall be recorded in the test report.

The measurement site may be a laboratory room with a minimum area of 6 metres by 7 metres and a height of at least 2.7 metres.

Other than the measuring apparatus and the operator, the room shall be as free as possible from reflecting objects other than the walls, floor and ceiling.

The principle of the site arrangement is shown in Figure III.1 (T/R 24-01).

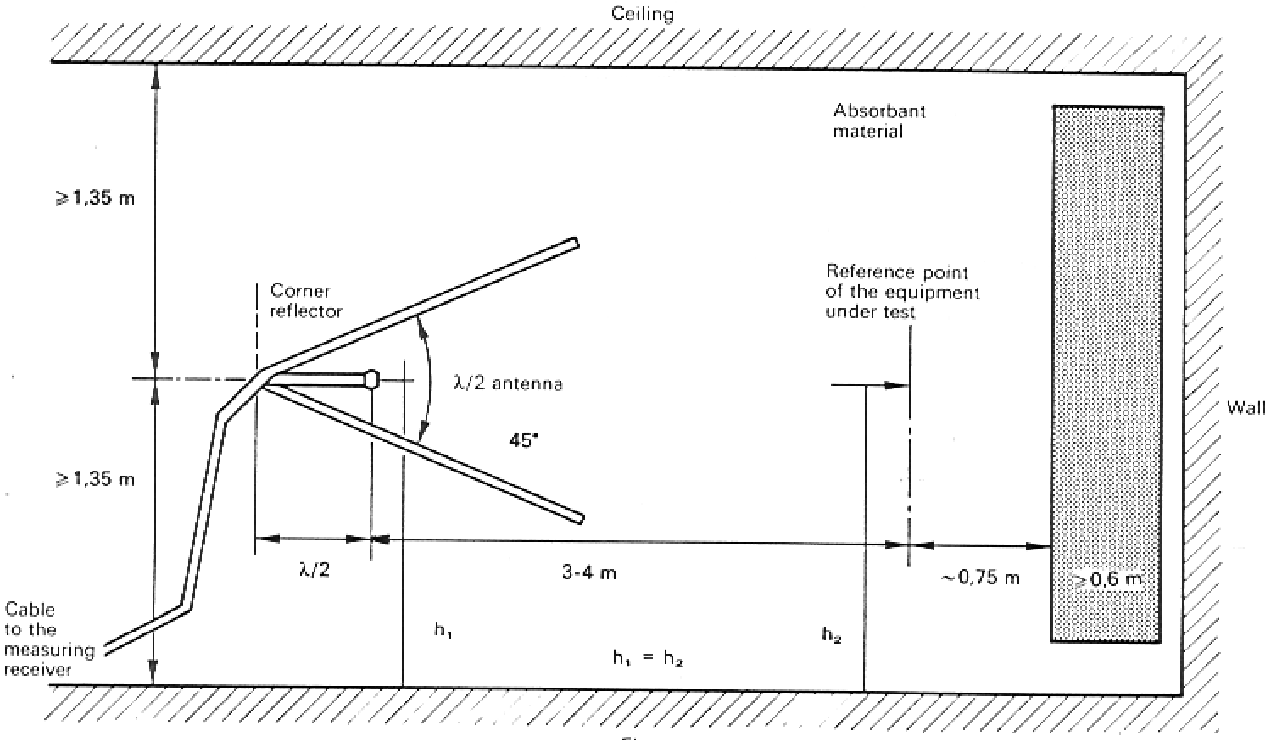

Figure III.1 (T/R 24-01). Indoor site arrangement (shown for horizontal polarization).

The potential reflections from the wall behind the equipment under test are reduced by placing a barrier of absorbent material in front of this wall. The corner reflector around the test antenna is used to reduce the effect of reflections from the opposite wall and from the floor and ceiling in the case of horizontally polarised measurements.

Similarly, the corner reflector reduces the effects of reflections from the side walls for vertically polarised measurements.

For the lower part of the frequency range (below approximately 175 MHz) no corner reflector or absorbent barrier is needed.

For practical reasons, the λ/2 antenna in Figure III.1 (T/R 24-01) may be replaced by an antenna of constant length, provided that this length is between λ/4 and λ as the frequency of measurement and the sensitivity of the measuring system is sufficient. In the same way the distance of λ/2 to the apex may be varied.

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The test antenna, test receiver, substitution antenna and calibrated signal generator are used in a way similar to that of the general method.

To ensure that errors are not caused by the propagation path approaching the point at which phase cancellation between direct and the remaining reflected signals occurs, the test sample shall be moved through a distance of ±10 cm in the direction of the test antenna as well as in the two directions perpendicular to this first direction. If these changes of distance cause a signal change of greater than 2 dB, the test sample should be resited until a change of less than 2 dB is obtained.

5.10. **Arrangement for test signals at the input of the transmitter**

For the purpose of this specification. the transmitter audio frequency modulation signal shall be supplied by a generator applied at the connections of the microphone terminal, unless otherwise stated. .

6. TRANSMITTER

6.1. Frequency error

6.1.1. *Definition*

The frequency error of the transmitter is the difference between the measured carrier frequency and its nominal value.

6.1.2. *Method of measurement*

The measurement shall be placed in a test fixture (Clause 5.7.) connected to the artificial antenna (Clause 5.6.).

The carrier frequency shall be measured in the absence of modulation. The measurement shall be made under normal test conditions (Clause 4.1) and extreme test conditions (Clauses 4.4. 1. and 4.4.2. applied simultaneously).

6.1.3. *Limit*

The frequency error shall not exceed the values given in Table III.1 (T/R 24-01), under both normal and extreme test conditions, or under any intermediate set of conditions.

Channel separation (kHz)	Frequency tolerance (kHz)				
	Below 47 MHz	47 to 100 MHz	100 to 300 MHz	300 to 500 MHz	500 to 1.000 MHz
20 and 25	± 0.6	± 1.35	± 2.0	± 2.5	± 2.5 (b)
12.5	± 0.6	± 1.0 (a)	± 1.5 (a)	± 1.5 (b)	No value

Table III.1 (T/R 24-01).

Notes to Table III-1 (T/R 24-01):

(a) Even tighter tolerance are desirable.

(b) The tolerances shown in the table tentative and for portable equipments having integral power supplies, the tolerance given shall not be exceeded over a temperature range of 0 to + 30° C. Under extreme temperature conditions (Clause 4.4.1.) the frequency error shall not exceed:
±2.5 kHz for a channel separation of 12.5 kHz between 300 and 500 MHz,
±3.0 kHz for channel separations of 20 and 25 kHz between 500 and 1.000 MHz.

6.2. Carrier power

It is assumed that Administrations will state the maximum permitted value of effective radiated power: this could be a condition for issuing the licence.

6.2.1. *Definition*

For the purpose of this specification, the carrier power is the effective radiated power in the direction of maximum fieldstrength under specified conditions of measurement (Clause 5A.) in the absence of modulation.

The rated carrier power shall be declared by the manufacturer.

6.2.2. *Method of measurement under normal test conditions*

On a test site. fulfilling the requirements of Clause 5.9. the sample shall be placed on the support in the following position:

(a) for equipment with an internal antenna. it shall stand so that the axis of the equipment which in its normal use is closest to the vertical shall be vertical;

(b) for equipment with a rigid external antenna. the antenna shall be vertical;

(c) for equipment with a non-rigid external antenna. the antenna shall be extended vertically upwards by a non-conducting support.

The transmitter shall be switched on without modulation, and the test receiver shall be tuned to the frequency of the signal being measured. The test antenna shall be oriented for vertical polarisation and shall be raised or lowered through the specified height range until the maximum signal level is detected on the test receiver.
The transmitter shall be rotated through 360° until a higher maximum signal is received.
It should be noted that this maximum may be a lower value than the value obtainable at heights outside the specified limits.
The transmitter shall be replaced by the substitution antenna. as defined in Clause 5.9. and the test antenna raised or lowered as necessary to ensure that the maximum signal is still received. The input signal to the substitution antenna shall be adjusted in level until an equal or a known related level to that detected from the transmitter is obtained in the test receiver.
The carrier power is equal to the power supplied to the substitution antenna. increased by the known relationship if necessary.
A cheek should be made at other planes of polarisation to ensure that the value obtained above is the maximum. If larger values are obtained, this fact should be recorded in the test report.

6.2.3. *Method* of *measurement under extreme test conditions*
The equipment shall be placed in the test fixture (Clause 5.7.), and the power delivered to the artificial antenna shall be measured. The measurement shall be made under normal test conditions (Clause 4.3.) and extreme test conditions (Clauses 4.4.1. and 4.4.2. applied simultaneously).

6.2.4. *Limit*
The carrier power under the specified test conditions of measurement (Clause 6.2.2.) and at normal test conditions shall be within ± 1.5 dB of the rated carrier power.
The carrier power under extreme test conditions shall be within +2 dB and -3 dB of the rated carrier power.
It the equipment is provided with a facility for reducing the carrier power, the requirements of this specification shall also be met when the transmitter is operating at reduced power.

6.3. Frequency deviation

The frequency deviation is the maximum difference between the instantaneous frequency of the modulated radio frequency signal and the carrier frequency in the absence of modulation.

6.3.1. *Maximum permissible frequency deviation*

6.3.1.1. Definition
The maximum permissible frequency deviation is the maximum value of frequency deviation agreed upon by convention for any specified channel separation.

6.3.1.2. Method of measurement
The equipment shall be placed in the test fixture (Clause 5.1) and the frequency deviation shall be determined by measuring the signal fed to the artificial antenna (Clause 5.6.), by means of a deviation meter suitable for the measurement of the maximum deviation, including that due to any harmonics and intermodulation products which may be produced in the transmitter. The modulation frequency shall be varied between the lowest frequency considered to be appropriate, and 3 kHz*. The level of this test signal shall be 20 dB above the level of the normal test modulation (Clause 5.5.).

6.3.1.3. Limits
The maximum permissible frequency deviation shall be as in Table III.2 (T/R 24-01) below:

Channel separation (kHz)	Maximum permissible frequency deviation (kHz)
25	± 5
20	± 4
12.5	± 2.5

Table 111.2 (MR 24-01).

* 2.55 kHz for transmitters intended for 12.5 kHz channel separation.

6.3.2. *Response of the transmitter at modulation frequencies exceeding 3 kHz**

6.3.2.1. Definition

The response of the transmitter to modulation frequencies above 3, kHz* is the frequency deviation expressed as a function of modulation frequencies above 3 kHz*.

6.12-2. Method of measurement

The transmitter shall be placed in the test fixture (Clause 5.1) and operated under normal test conditions (Clause4.3.). The transmitter shall be modulated with normal test modulation (Clause 5.5.). With a constant input level of the modulation signal. the modulation frequency shall be varied from 3 kHz* to a frequency equal to the channel separation for which the equipment is intended, and the frequency deviation shall be measured by means of a deviation metre as described in Clause 6.3.1.2.

6.3.2.3. Limits

The frequency deviation at modulation frequencies between 3 kHz* and 6 kHz shall not exceed the frequency deviation at a modulation frequency at 3 kHz*. At 6 kHz the deviation shall be at least 6 dB below the deviation at a modulation frequency of 1 kHz. The frequency deviation at modulation frequencies between 6 kHz and a frequency equal to the channel separation for which the equipment is intended shall not exceed that given by a linear response of frequency deviation (in decibels) against_modulation frequency. starting at a point where the modulation frequency is 6 kHz and the deviation at least 6 dB below the value at 1 kHz and having a slope of 14 dB per octave. the frequency deviation diminishing as the modulation frequency is increased.

6.4. Adjacent channel power

6.4.1. *Definition*

The adjacent channel power is that part of the total power output of a transmitter under defined conditions of modulation, which falls within a specified passband centred on the nominal frequency of either of the adjacent channels. This power is the sum of the mean power produced by the modulation, hum and noise of the transmitter.

6.4.2. *Methods of measurement*

6.4.2.1. General remarks

Two methods are proposed, the results of which are equivalent. The member Administrations of CEPT are requested to use one or both of these methods. The method applied shall be stated in the test reports.
Note. When using the test fixture for this measurement, it is important to ensure that direct radiation from the transmitter to the power measuring receiver or spectrum analyser does not affect the result.

6.4.2.2. Method of measurement using a power measuring receiver

The adjacent channel power may be measured with a power measuring receiver which conforms to Clause 6.4.2.3. (referred to in Clauses 6.4.2.2. and 6.4.2.3. as the “receiver”).

(a) The transmitter shall be placed in the test fixture (Clause 5.7.) and operated at the carrier power (Clause 6.2.1) under normal test conditions (Clause 4.1). The output of the test fixture shall be applied to the input of the “receiver” at a level that is appropriate.

(b) With the transmitter unmodulated ** the tuning of the “receiver” shall be adjusted so that a maximum is obtained. This is the 0 dB response point. The “receiver” attenuator setting and the reading of the meter shall be recorded.

(c) The tuning of the “receiver” shall be adjusted away from the carrier so that the “receiver’s” -6 dB response nearest the transmitter carrier frequency is located at a displacement from the nominal carrier frequency as given in Table III-3 (T/R 24-01).

* 2.55 kHz for transmitters intended for 12.5 kHz channel separation.

**The measurement may be made with transmitter modulated with normal test modulation (Clause 5.5.) in which case this fact shall be recorded along with the measurement results.

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Channel separation (kHz)	Specified necessary bandwidth (kHz)	Displacement of the 6 dB point
25	16	17
20	14	13
12.5	8.5	8.25

Table III.3 (T/R 24-01).

(d) The transmitter shall be modulated with 1.250 Hz at a level which is 20 dB higher than that required to produce 60% of the maximum permissible deviation (Clause 6.3.1.).

(e) The "receiver" variable attenuator shall be adjusted to obtain the same meter reading as in step (b) or a known relation to it.

(f) The ratio of adjacent channel power to carrier power is the difference between the attenuator settings in steps (b) and (e), corrected for any differences in the reading of the meter.

(g) The measurement shall be repeated with the "receiver" tuned to the other side of the carrier.

6.4.2.3. Power measuring receiver specification

The power measuring receiver consists of a mixer, an IF-filter, an oscillator, an amplifier, a variable attenuator and a rms value indicator. Instead of the variable attenuator with the rms indicator it is also possible to use a dB-calibrated rms voltmeter.

The technical characteristics of the power measuring receiver are given below.

6.4.2.3.1. IF-filter

The IF-filter shall be within the limits of the following selectivity characteristic in Figure III-2 (T/R 24-01).

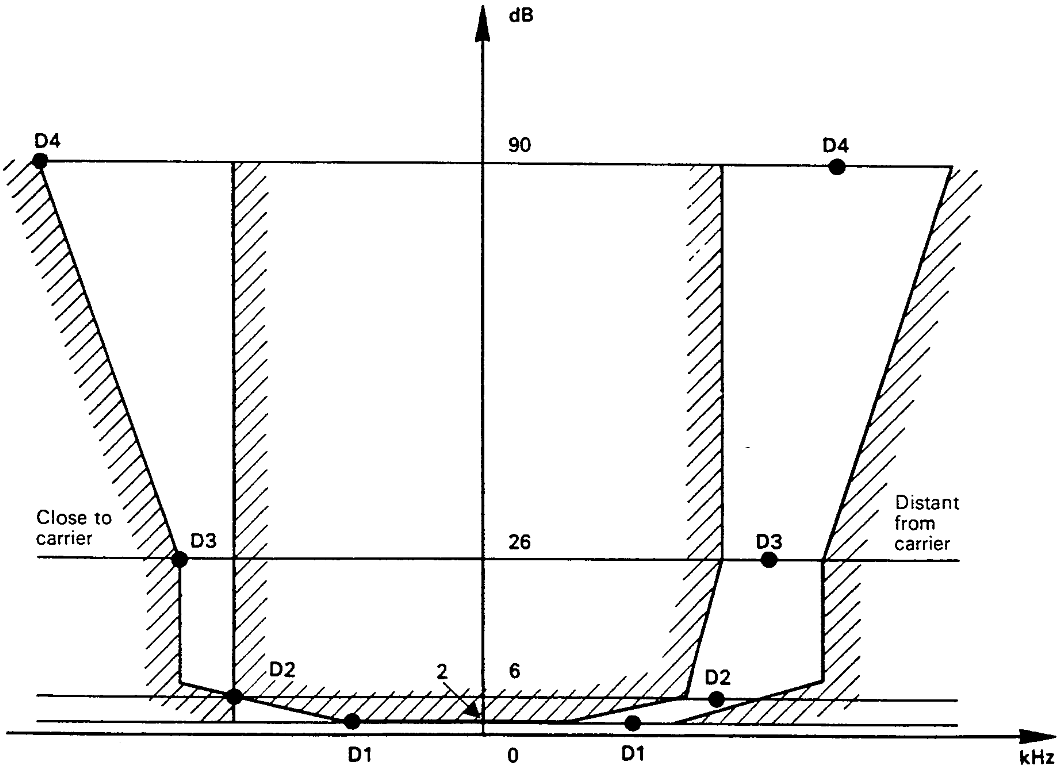

Figure III.2 (T/R 24-01).

Depending on the channel separation, the selectivity characteristic shall keep the following frequency separations from the nominal centre frequency of the adjacent channel given in Table III-4 (T/R 24-01).

Channel separation (kHz)	Frequency separation of filter curve from nominal centre frequency of adjacent channel (kHz)			
	D1	D2	D3	D4
12.5	3	4.25	5.5	9.5
20	4	7.0	8.25	12.25
25	5	8.0	9.25	13.25

Table III.4 (T/R 24-01).

Depending on the channel separation, the attenuation points shall not exceed the following tolerances given in Tables III-5 (T/R 24-01) and III-6 (T/R 24-01).

Channel separation (kHz)	Tolerances range (kHz))			
	D1	D2	D3	D4
12.5	+ 1.35	± 0.1	- 1.35	- 5.35
20	+ 3.1	± 0.1	- 1.35	- 5.35
25	+ 3.1	± 0.1	- 1.35	- 5.35

Table III.5 (T/R 24-01). Attenuation points close to carrier.

Channel separation (kHz)	Tolerances range (kHz))			
	D1	D2	D3	D4
12.5	+ 1.35	± 0.1	- 1.35	- 5.35
20	+ 3.1	± 0.1	- 1.35	- 5.35
25	+ 3.1	± 0.1	- 1.35	- 5.35

Table III.6 (T/R 24-01). Attenuation points distant from the carrier.

The minimum attenuation of the filter outside the 90 dB attenuation points must e equal to or greater than 90 dB

6.4.2.3.2. Attenuation indicator

The attenuation indicator shall have a minimum range of 80 dB and a reading accuracy of 1 dB. With a view to future regulations an attenuation of 90 dB or more is recommended.

6.4.2.3.3. Rms value indicator

The instrument shall accurately indicate non-sinusoidal signals in a ratio of 10: 1 between peak value and rms value.

6.4.2.3.4. Oscillator and amplifier

The oscillator and the amplifier shall be designed in such a way that the measurement of the adjacent channel power of a unmodulated transmitter, whose noise has a negligible influence on the measurement result, yields a measured value of ≤5 -90 dB for channel separation of 20 and 25 kHz and of ≤5 -80 dB for a channel separation of 12.5 kHz referred to the carrier of the oscillator.

6.4.2.4. Method of measurement using a spectrum analyser

It should be noted that this method of measurement requires a spectrum analyser with a very low SSB phase noise and a wide dynamic range. A transmitter can exceed the limit for the adjacent channel power by the noise it produces; therefore the power of this noise shall be integrated. For a transmitter producing - 70 dB of noise power in its adjacent channel, this requires a spectrum analyser giving an indicated noise level of less than -76 dB with respect to a CW signal, integrated over the adjacent channel for such a CW signal. As an example, this is achieved (for channel separation of 20 or 25 kHz) when the noise, indicated with a resolution bandwidth of 100 Hz, is 100 dB below the indicated amplitude of the CW signal over the bandwidth of the adjacent channel.

The adjacent channel power may be measured with a spectrum analyser, which conforms, to Clause 6.4.2.5. The transmitter shall be placed in the test fixture (Clause 5.7) and operated at the carrier power under normal test conditions (Clause 4.3). The radio frequency output of the test fixture shall be applied to the input of a spectrum analyser at a level that is appropriate. The transmitter shall be modulated at 1,250 Hz at a level, which is 20 dB greater than that required to produce 60% of the maximum permissible deviation (Clause 6.3.1.).
The spectrum analyser shall be adjusted so that the spectrum of the transmitter output, including that part which falls in the adjacent channels, is displayed.

For the purpose of this test, the bandwidth of a receiver of the type normally used in the system shall be taken to be:
(a) 16 kHz for 25 kHz channel separation;
(b) 14 kHz for 20 kHz channel separation;
(c) 8.5 kHz for 12.5 kHz channel separation.

The centre frequency of the bandwidth within which measurements are to be made shall have a separation from the nominal carrier frequency of the transmitter, equal to the channel separation for which the equipment is intended.
The adjacent channel power is the sum of the power levels of each of the discrete components and of the noise falling in the appropriate bandwidth.
The difference between the input levels, in dB, gives the ratio of the adjacent channel power to the carrier output power.
The adjacent channel power expressed as an effective radiated power is calculated by applying this rations to the carrier power as determined in Clause 6.2.2.
The measurement shall be repeated for the other adjacent channel.

6.4.2.5. Characteristic of the spectrum analyser specification
The characteristic of the spectrum analyser shall meet at least the following requirements: It shall be possible to measure the amplitude of a signal or noise at a level 3 dB or more above the noise level of the spectrum analyser as displayed on the screen, to an accuracy of ±:2 dB in the presence of a signal separated in frequency by:
(a) 10 kHz. at a level 90 dB above that of the signal to be measured for 25 and 20 kHz channel separations, and
(b) 6.25 kHz, at a level 80 dB above that of the signal to be measured for a 12.5 kHz channel separation.

The reading accuracy of the frequency marker shall be within ± 0.1 kHz.
The accuracy of relative amplitude measurements shall be within :± 1 dB.
It shall be possible to adjust the spectrum analyser to allow the separation on its screen of two components with a frequency difference of 1 kHz.

6.4.2.6. Integrating and power summing device
This device would only be used if the sum of the components and the noise has not been calculated automatically (see above). It is connected to the video output of the spectrum analyser, described in Clause 6.4.2.5. It shall be possible to sum the effective power of all discrete components and the noise power falling in the selected bandwidth and to measure this as a ratio relative to the carrier power. The position and the width of the integration range selected can be indicated on the spectrum analyser by brightening the trace. When measuring power levels as low as 50 nanowatts, the output of the device should exceed the integral noise level by at least 10 dB. The dynamic range shall permit measurement of the values required under Clause 6.4.3. with a reserve of at least 10 dB.

6.4.3. *Limits*
For channel separations of 20 kHz and 25 kHz the adjacent channel power shall not exceed a value of 70 dB below the carrier power of the transmitter without any need to be below 0.2 microwatt. For channel separations of 12.5 kHz. the adjacent channel power shall not exceed a value of 60 dB below the transmitter carrier power without any need to descend below 0.2 microwatt.

6.5. Spurious emissions

6.5.1. *Definition*
Spurious emissions are emissions at frequencies other than those of the carrier and sidebands associated with norm modulation radiated by the equipment and its antenna.

6.5.2. *Method of measurement*

On a test site, fulfilling the requirements of Clause 5.9., the sample shall be placed at the specified height on the support. The transmitter shall be operated without modulation at the carrier power as measured under Clause 6.2.2.

The radiation of any spurious component shall be detected by the test antenna and receiver, over the frequency range *30* MHz - 4 GHz except for the channel on which the transmitter is intended to operate and its adjacent channels. In addition, for equipment operating on frequencies above 470 MHz, measurements may be repeated over the frequency range 4 GHz – 12.5 GHz.

At each frequency at which a component is detected, the sample shall be rotated to obtain maximum signal and the effective radiated power of that component shall then be determined by a substitution measurement.

The measurements shall be repeated with the test antenna in the orthogonal polarisation plane.

The measurements shall be repeated with the transmitter modulated the normal test modulation (Clause 5.5.).

The measurements shall be repeated with the transmitter in stand-by condition.

6.5.3. *Limits*

The effective radiated power of any spurious emission shall not exceed the value given below.

	100 kHz to 1 GHz	1 GHz to 12.5 GHz
Tx. Operating Standby	0.25 microwatt 2 nanowatt	1 microwatt 20 nanowatt

6.6. **Transient behaviour of the transmitter**

The transient behaviour of the transmitter can be verified with the method of measurement given in Appendix B.

7. RECEIVER

7.1. Maximum usable sensitivity expressed as a fieldstrength

7.1.1. *Definition*

The maximum usable sensitivity is the minimum fieldstrength of a signal, at the nominal frequency of the receiver, with normal test modulation (Clause 5.5.), which will produce:

7.1.1.1. in all cases, an audio frequency output power of at least 50% of the rated power output (Clause 5.4.), and

7.1.1.2. either a SND/ND*) ratio of *20* dB. measured at the output of the receiver, with a telephone psophometric weighting network as described in CCITT Recommendation P.53A, or

7.1.1.3. a SND/N ratio of 20 dB. measured with the psophometric network mentioned in Clause 7.1.1.2.

Note 1. The CEPT considers that these alternatives will give closely similar results. Member Administrations of CEPT are requested to state, in their type approval test reports. which method or methods have been used.

Note 2. The characteristics of the 1 kHz band-stop filter used in SND/ND measurements shall be such that at the output the attenuation at 1 kHz will be at least 40 dB, and that at 2 kHz it shall not exceed 0.6 dB. The filter characteristic shall be flat within 0.6 dB over the ranges of 20 Hz to 500 Hz and 2 kHz to4 kHz. In the absence of modulation, the filter must not cause more than 1 dB attenuation of the total noise output power at the audio frequency output of the receiver under test.

7.1.2. *Method of measurement making use of the squelch or call-alarm circuit*

This method makes use of squelch or call-alarm circuits and is thus only applicable to equipment so fitted. Before commencing the measurement, the squelch threshold control shall be adjusted to ensure the receiver is muted (squelched) and thereafter shall not be changed during the measurements.

*)S Signal.
N Noise.
D Distortion.

7.1.2.1. Initial calibration procedure

On a test site, fulfilling the requirements of Clause 5.9., the sample shall be placed on the support in the following position:

(a) for equipment, with internal antenna, it shall stand so that the axis of the equipment, which in its normal use is closest to the vertical, shall be vertical;
(b) for equipment with a rigid external antenna, the antenna shall be vertical;
(c) for equipment with a non-rigid external antenna. the antenna shall be extended vertically upwards by a non-conducting support.

The test antenna (Clause 5.9.2.) shall be at a similar distance from the receiver under test as was used between the transmitter and the test antenna in the carrier power measurement in Clause 6.2.2. The test signal fed to the test antenna from the signal source shall have a frequency equal to the nominal frequency of the receiver and shall be modulated with the normal test modulation and, if necessary, with a tone for the "squelch" or the call alarm circuit.

The output level of the test generator is increased from a low level until the receiver squelch circuit is just switched, that is, at the threshold at which the tone output becomes continuous. The operation shall be repeated while the receiver is rotated through 360° until the lowest value of generator output, which just operated the squelch circuit, has been determined.
With the test generator output amplitude maintained at this level, the receiver under test is replaced by the substitution antenna connected to the calibrated measuring receiver and the fieldstrength, X dB relative to 1 microvolt per metre is recorded.
The receiver under test is now placed in the test fixture, and the above-mentioned test signal is applied to the fixture. The test conditions, when using the test fixture, shall be the same as on the test site. Special attention is required concerning the temperature. The level of the signal shall be increased from a low level until the receiver squelch circuit is at the threshold. The level of the signal generator for this criterion. Y dB relative to 1 microvolt, is recorded.

7.1.2.2. SND/ND method of measurement

A signal of carrier frequency equal to the nominal frequency of the receiver and with normal test modulation according to Clause 5.5. shall be applied to the RF input terminals of the test fixture. An audio frequency output load and a distortion factor meter, incorporating a 1 kHz band elimination filter and psophometric telephone weighting network as mentioned in Clause 7.1.1.2., shall be connected to the receiver output terminals. Where possible the receiver volume control shall be adjusted to give 50% of the rated output power as defined in Clause 5.4. and in the case of stepped volume controls. to the first step that provides an output power of at least 50% of the rated power output.
Under normal test conditions, the test signal input level shall be reduced until a SNDIND ratio of 20 dB is obtained. The test signal input level under these conditions is recorded as Z dB relative to 1 microvolt. The maximum usable fieldstrength sensitivity is determined by the expression: X + (Z - Y) dB relative to 1 microvolt per metre.

The measurement shall be made under normal test conditions (Clause 4.1.) and extreme test conditions (Clauses 4.4.1. and 4.4.2. applied simultaneously). The tests under extreme test conditions require only the determination of a new value Z for the above equation. Under extreme test conditions, a variation of the receiver output power of = 3 dB relative to the value obtained under normal test conditions may be allowed.

7.1.2.3. SND/N method of measurement

A signal of carrier frequency equal to the nominal frequency of the receiver and with normal test modulation according to Clause 5.5. shall be applied to the RF input terminals of the test fixture. An audio frequency output load and a psophometric telephone weighting network as mentioned in Clause 7.1.1.2. shall be connected to the receiver output terminals. Where possible the receiver volume control shall be adjusted to give 50% of the rated output power as defined in Clause 5.4. and in the case of stepped volume controls, to the first step that provides an output power of at least 50% of the rated power output. The test signal input level shall be reduced until a SND/N ratio of 20 dB is obtained (for this measurement the modulation is switched on and off).
The test signal input level under these conditions is recorded as Z dB relative to 1 microvolt
The maximum usable fieldstrength sensitivity is determined by the expression: X + (Z - Y) dB relative to 1 microvolt per metre.

The measurement shall be mace under normal test conditions (Clause 4.3.) and extreme test conditions (Clauses 4.4.1. and 4.4.2. applied simultaneously). The tests under extreme test conditions require only the determination of a new value Z for the above equation.
Under extreme test conditions. a variation of the receiver output power of ±3 dB relative to the value obtained under normal test conditions may be allowed.

7.1.2. Method of measurement using an acoustic measuring arrangement

7.1.3.1. Initial tests

In order to determine the acoustic SND/ND or SND/N ratio which is equivalent to the normal SND/ND or SND/N ratio at the receiver output the equipment under test shall be positioned in the test fixture (5.7.) and an audio frequency output load and a distortion factor meter, incorporating a 1 kHz band elimination filter and psophometric telephone weighting network as mentioned in Clause 7.1.1.2 for the SND/ND ratio or an audio frequency output load and a psophometric telephone weighting network mentioned above for the SND/N ratio are connected to the receiver output terminals.
A signal of carrier frequency equal to the nominal frequency of the receiver and with normal test modulation according to Clause 5.5. shall be applied to the RF input terminals of the test fixture. Where possible the receiver volume control shall be adjusted to give 50% of the rated output as defined in Clause 5.4. and in the case of stepped volume controls, to the first step that provides an output power of a least 50% of the rated power output.
The test signal input level shall be reduced until a SND/ND) ratio or a SND/N ratio of 20 dB is obtained. The adjusted signal input level will be recorded.
The acoustical measuring arrangement (Clause 5.3.) shall be coupled to the receiver and with the same signal input level the acoustic SND/ND or SND/N ratio shall be measured and recorded.
Repeat the same measurements for a SND/ND or SND/N ratio for 14 dB and record the equivalent acoustic SND/ND or SND)/N radio for use in the following immunity tests.
For the measurements stated in Clauses 7.l., 7.2., 7.1., 7.4., 7.5. and 7.6. the acoustic SN/ND or SND/ND ratio is used instead of the normal SND/ND or SND/N ratio.

7 1 3 2. Method of measurement

On a test site, fulfilling the requirements of Clause 5.9., the sample shall be placed on the support in the following position:

(a) for equipment with internal antenna, it shall stand so that the axis of the equipment which in its normal use is closest to the vertical. shall be vertical;
(b) for equipment with a rigid external antenna, the antenna shall be vertical;
(c) for equipment with a non-rigid external antenna, the antenna shall be extended vertically upwards by a non-conducting, support.

The test antenna (Clause 5.9.2.) shall be at a similar distance from the receiver under test as was used between the transmitter and the test antenna in the carrier power measurement in Clause 6.2.2.
A signal of carrier frequency equal to the nominal frequency of the receiver and with normal test modulation according to Clause 5.5. shall be applied to the test antenna.
An audio frequency output load and a psophometric telephone weighting network as mentioned in Clause via the 7.1.1.2. shall be connected to the receiver output terminals tie measuring arrangement (Clause 5.3). In addition a distortion factor meter incorporating a 1 kHz stop filter shall be used when measuring the SND/ND ratio instead of SND/N ration. Where possible the receiver volume control shall be adjusted to give 50% of the rated output power as defined in Clause 5.4. and in the case of stepped volume controls, to the first step that provides an output power of at least 50% of the rated power output. The test signal input level shall be reduced until the equivalent acoustic SND/ND or SN/DN ratio for the normal SND/ND or SND/N ratio of 20 dB (Clause 7.1.2.) is obtained. The operation shall be repeated while the receiver is rotated through 360° until the lowest value of the generator output which produces the equivalent acoustic SND/ND or SND/N ratio again is obtained.
With the test generator output amplitude maintained at this level, the receiver under test is replaced by the substitution antenna connected to the calibrated measuring receiver and the fieldtrength. in dB relative to 1 microvolt per metre, is recorded.
The recorded fieldstrength is the maximum usable sensitivity expressed as fieldstrength.
The measurement shall be made under normal test conditions (Clause 4.1) and extreme test conditions (Clauses 4.4.1. and 4.4.2. applied simultaneously).

In order to do the test under extreme test conditions, the receiver under test is placed in the test fixture. Firstly a measurement is carried out under normal test conditions. It is essential that during this part of the procedure the test conditions shall be the same as were present during measurements on the test site. Special attention is required concerning the temperature.

The test signal input level shall be adjusted so that the acoustical equivalent of an SND/ND or SND/N ratio of 20 dB is produced at the output of the receiver. The amplitude of the test signal input level is noted. Secondly, under extreme test conditions, the amplitude of the test signal input level is increased or decreased to produce again the acoustical equivalent of an SND/ND or SND/N ratio of 20 dB at the output of the receiver and the amplitude of the test signal input level is noted. The increase or the decrease of the input signal level is calculated.

The maximum usable sensitivity expressed as a fleldstrength under extreme test conditions is equal to the maximum usable sensitivity expressed as fieldstrength (under normal test conditions), increased or decreased by the figure calculated in the previous step.

Under extreme test conditions, a variation of the receiver output power of :± 3 dB relative to the value obtained under normal test conditions may be allowed.

7.1.4. *Limits*

The maximum usable sensitivity expressed as fieldstrength in dB, relative to 1 microvolt per metre shall not exceed the values given below.

For category A equipment (see scope of specifications): Table III.7 (T/R 24-01).

Frequency band	Maximum usable sensitivity, Expressed as fieldstrength in dB, relative to 1 microvolt per metre	
	Normal test conditions	Extreme test conditions
30 to 100 MHz	14	20
100 to 230 MHz	20	26
230 to 470 MHz	26	32
470 to 1.000 MHz	32	38

Table III.7 (T/R 24-01).

For category B equipment (see scope of specifications):
32 dB above one microvolt per metre under normal test conditions and
38 dB above one microvolt per metre under extreme test conditions.

7.2. Amplitude characteristic of receiver limiter

7.2.1. *Definition*

The amplitude characteristic of the receiver limiter is the relationship between the radio frequency input level of a specified modulated signal, and the audio frequency level at the receiver output.

7.2.2. *Method of measurement*

The receiver shall be placed in the test fixture. A test signal at the nominal frequency of the receiver, with normal test modulation (Clause 5.5.), at a level which is equivalent to the level of the limit of the maximum usable sensitivity expressed as fieldstrength (Clause 7.1.4.) shall be applied to the input of the test fixture, and the audio output shall be adjusted to give a level of approximately 25% of the rated output power (Clause 5.4.). In the case of stepped volume control, the control shall be set to the first stop that provides an output power of at least 25% of the rated output power. The input signal shall be increased by 70 dB and the level of the audio output shall again be measured.

7.2.3. *Limit*

For the specified change in radio frequency input level, the change of audio output level shall not exceed 3 dB between the maximum and minimum output levels.

7.3. Co-channel rejection

7.3.1. *Definition*

The co-channel rejection is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal, both signals being at the nominal frequency of the receiver.

7.3.2. *Method of measurement*

The receiver shall be placed in a test fixture The two input signals shall be connected to the test fixture via a combining network (see also Clause 5.1.). The wanted signal shall have normal test modulation (Clause 5.5.). The unwanted signal shall be modulated with a frequency of 400 Hz at a deviation of 60% of the maximum permissible frequency deviation (Clause 6.3.1).

Both input signals shall be at the nominal frequency of the receiver under test and the measurement repeated for displacements of the unwanted signal of up to ± 3,000 Hz.

Initially the generator for the unwanted signal shall be switched off (maintaining its output impedance). The level of the wanted signal shall then be adjusted to a level which is equivalent to the level of the limit for the maximum usable sensitivity expressed as fieldstrength (Clause 7.1.4.).

For equipment making use of a squelch - or call - alarm circuit the level of the maximum usable sensitivity expressed as fieldstrength will be found as follows: the level of the wanted signal shall be increased from a low level until the receiver squelch circuit is at the threshold. The level of the wanted signal shall then be increased by the difference between the limit for the "maximum usable sensitivity expressed as fieldstrength" for the relevant frequency band and the value X (Clause 7.1.2).

The output power of the wanted signal shall be adjusted, where possible, to 50% of the rated output power and in the case of stepped volume controls to the first step that provides an output power of at least 50% of the rated output power.

The unwanted signal shall then be switched on and the input level shall be so adjusted that the unwanted signal causes.

(a) a reduction of 3 dB in the output level of the wanted signal, or

(b) a reduction to 14 dB of the SND/ND or SND/N ratio at the receiver output (with a psophometric filter), whether or not measured acoustically, whichever occurs first.

The co-channel rejection ratio shall be expressed as the ratio in dB. of the level of the unwanted signal to the level of the wanted signal at the test fixture input, for which the above-mentioned reduction in SND/ND or SND/N ratio or reduction in output level occurs.

7.3.3. *Limits*

The co-channel rejection ratio at any frequency of the unwanted signal within the specified range shall be greater than:

- 8 dB for channel separations of 20 kHz and 25 kHz,
- 12 dB for a channel separation of 12.5 kHz

7.4. Adjacent channel selectivity

Definition

The adjacent channel selectivity is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal which differs in frequency from the wanted signal by that spacing between adjacent channels for which the equipment is intended.

7.4.2. *Method of measurement*

The receiver shall be placed in a test fixture. The two input signals shall be connected to the test fixture via a combining network (see also Clause 5.1.).

The wanted signal shall be at the nominal frequency of the receiver and shall have normal test modulation (Clause 5.5.). The unwanted signal shall be modulated with a frequency of 400 Hz at a deviation of 60% or the maximum permissible deviation (Clause 6.3.1.), and shall be at the frequency of the channel immediately above that of the wanted signal.

Initially the generator for the unwanted signal shall be switched off (maintaining its output impedance). The level of the wanted signal shall then be adjusted to a level which is equivalent to the level of the limit for the maximum usable sensitivity expressed as fieldstrength (Clause 7.1.4.).

For equipment making use of a squelch-or call-alarm-circuit the level of the maximum usable sensitivity expressed as fieldstrength will be found as follows: the level of the wanted signal shall be increased from a low level until the receiver squelch circuit is at the threshold. The level of the wanted signal shall then be increased by the difference between the limit for the "maximum usable sensitivity expressed as fieldstrength" for the relevant frequency band and the value X (Clause 7.1.2).
The output power of the wanted signal shall be adjusted, where possible, to 50% of the rated output power and in the case of stepped volume controls to the first step that provides an output power of at least 50% of the rated output power.
The unwanted signal shall then be switched on and the level adjusted so that the unwanted signal causes:
(a) a reduction of 3 dB in the output level of the wanted signal, or
(b) a reduction to 14 dB of the SND/ND or SND/N ratio at the receiver output (with a psophometric filter), whether or not measured acoustically, whichever occurs first.
This measurement shall be repeated with the unwanted signal at the frequency of the channel below that of the wanted signal. The adjacent channel selectivity shall be expressed as the lower value of the ratios in dB for the upper and lower adjacent channels of the level of the unwanted signal to the level of the wanted signal.
These measurements shall be repeated under extreme test conditions (Clauses 4.4.1. and 4.4.2. applied simultaneously).

7.4.3. Limits
The adjacent channel selectivity for different categories of equipment and for different channel separation shall not be less than the values given in the following table:

		Channel separation	
		12.5 kHz	20/25 kHz
Category A	Normal test conditions	60 dB	70 dB
	Extreme test conditions	50 dB	60 dB
Category B	Normal test conditions	60 dB	60 dB
	Extreme test conditions	50 dB	50 dB

7.5. Spurious response rejection

7.5.1. *Definition*
The spurious response rejection is a measure of the capability of the receiver to discriminate between a wanted modulated signal at the nominal frequency and an unwanted signal at any other frequency at which a response is obtained.

7.5.2. Method of measurement

7.5.2.1. General
Two methods of measurement are described the results of which are comparable. One measurement making use of an acoustic measuring arrangement, shows the degradation of the performance of the receiver due to spurious responses. The other method of measurements, using the squelch-or call alarm-circuit, shows the unwanted response of the receiver. Administration may use one or both methods. The method applied shall be stated in the test report.
During the course of this measurement on the test site (Clause 5.9.*).* it may be necessary to radiate high powers at frequencies over the range 30 MHz - 2 GHz (for equipment operating on frequencies up to 470 MHz), and over the range 30 MHz - 4 GHz (for equipment operating on frequencies over 470 MHz), and care must be taken to avoid these signals causing interference to existing services that may be operating in the neighbourhood. To overcome these difficulties the use of the stripline arrangement (Clause 5.8.) is strongly recommended.

7.5.2.2. Method of measurement using an acoustic measuring arrangement, see Clause 5.3.

On a test site fulfilling the requirements of Clause 5.9. or in a stripline arrangement (Clause 5.8.), the receiver shall be placed in the position used for the test under Clauses 7.1.2.1. or 7.1.3.1. The test signal fed to the test antenna or to the stripline input terminal from the signal source shall have a frequency equal to the nominal frequency of the receiver, and shall be modulated with normal test modulation (Clause 5.5.) and, if necessary, with a tone for the squelch or the call alarm circuit,

The level of the wanted signal shall be adjusted to a level which is equivalent to the level of the limit for the maximum usable sensitivity expressed as fieldstrength. The unwanted signal shall be modulated with a frequency of 400 Hz with a deviation of 60% of the maximum permissible deviation (Clause 6.3.1.3). The level of the unwanted signal shall be adjusted to a level which is 80 dB in excess of a level which is equivalent to the level of the limit for the maximum usable sensitivity expressed as fieldstrength (Clause 7.1.4).

Eventually changing the test antenna (when measuring on the test site) as necessary for each frequency band, adjust the generator over the range 30 MHz - 2 GHz (for equipment operating on frequencies up to 470 MHz) or over the range 30 MHz - 4 GHz (for equipment operating on frequencies over 470 MHz), and note the frequencies where spurious responses occur.

At each of these noted frequencies, the amplitude of the unwanted signal shall be adjusted until the acoustic SND/ND or SNI)/N ratio which is equivalent to the reduced normal SND/ND or SND/N ratio of 14 dB is obtained. All these ratios are psophometrically weighted.

At the test site, at each frequency, the receiver is replaced by the calibrated antenna of a fieldstrength meter and the fieldstrength is recorded.

The difference between the fieldstrength of the unwanted signal and the limit for the maximum usable sensitivity expressed as fieldstrength is the spurious response rejection radio. It is expressed as ratio in dB.

7.5.2.3. Method of measurement using the squelch or call-alarm circuit

On a test site fulfilling the requirements of Clause 5.9. or in a stripline arrangement (Clause 5.8.), the receiver shall be placed in the, position used for the test under Clause 7.1.2.1. The test signal fed to the test antenna from the signal source shall have a frequency equal to the nominal frequency of the receiver, and shall be modulated with normal test modulation (Clause 5.5.) and, if necessary, with a tone for the squelch or the call alarm circuit. The output level of the test generator signal applied to the test antenna or to the stripline arrangement is adjusted to create a fieldstrength which is equivalent to the limit for the maximum usable sensitivity expressed as fieldstrength (Clause 7.1.4.) around the integral antenna of the receiver.

The output level of the generator shall be increased by at least 80 dB and the test antenna changed as necessary for each frequency band. The frequency of the generator shall then be adjusted over the range 30 MHz - 2 GHz (for equipment operating on frequencies up to 470 MHz) or over the range 30 MHz - 4 GHz (for equipment operating on frequencies over 470 MHz). The frequencies at which the squelch circuit is opened shall be noted.

At each of these noted frequencies, the output level of the generator shall be adjusted until the squelch circuit just closes. When using the acoustical measuring arrangement, the amplitude shall be adjusted until the acoustic SNDIND or SNDIN ratio which is equivalent to the reduced normal SND/ND or SNI)/N ratio of 14 dB is obtained.

All these ratios are psophometrically weighted.

7.5.3. Limits

At any frequency separated from tile nominal frequency of the receiver by more than one channel separation, the spurious response rejection ratio shall be greater than:

(a) for equipment of category A: 70 dB
(b) for equipment of category B: 50 dB.

7.6. Intermodulation response

7.6.1. Definition

The intermodulation response is a measure of the capability of the receiver to receive a wanted modulation signal without exceeding a given degradation due to the presence of two or more unwanted signals with a specific frequency relationship to the wanted signal frequency.

7.6.2. Method of measurement

The receiver shall be placed in the test fixture (Clause 5.7.). The three signal generators A, B and C shall be connected to the test fixture via a combining network. The wanted signal represented by signal generator A shall be at the nominal frequency of the receiver and shall have normal test modulation (Clause 5.5.). The unwanted signal from signal generator B shall be unmodulated and adjusted to the frequency separated by one channel separation above the nominal frequency of the receiver. The second unwanted signal from signal generator C shall be modulated with a frequency of 400 Hz with a deviation of 60% of the maximum permissible deviation (Clause 6.3.1.3.) and adjusted to the frequency separated by two-channel separation above the nominal frequency of the receiver.

Initially the generators for the unwanted signals shall be switched off (but maintaining their output impedance) and the wanted signal shall be adjusted to the level of the limit for the maximum usable sensitivity (Clause 7.1.4.). This step requires the measurement of maximum usable fieldstrength (Clause 7.l.) to be carried out and the test fixture calibration factor (Clause 7.1.2.l.) to be known. The generators for the unwanted signals shall be switched on, maintained equal and adjusted until the SND/ND or SND/N ratio at the receiver output, psophometrically weighted, is reduced to 14 dB. The frequency of signal generator B shall be adjusted slightly to produce the maximum degradation of the SND/ND ratio or SND/N ratio. The level of the two unwanted test signals shall be re-adjusted to restore the SND/ND or SND/N ratio of 14 dB.

The measurements shall be repeated with the unwanted signal B at the frequency of the channel below that of the wanted signals and the frequency of the unwanted signal C at the frequency two channels below that of the wanted signal.

The ratio, in dB, of the output level of signal generators B and C, to that noted for generator A, is the intermodulation response ratio.

The measurement shall be repeated with frequency separations of up to 4 and 8 times the channel separation. However, category A equipment designed to operate with a 12.5 kHz channel separation need not be measured with an unwanted signal in an adjacent channel.

7.6.3. Limits

The intermodulation response ratio shall not be less than 65 dB for category A equipment and not less than 50 dB for category B equipment.

It should be noted that the intermodulation response ratio measured according to the two-signal generator method (see Annex I. Clause 5.7.) produces a figure which is less than 5 dB higher than that produced with the three-signal generator method.

7.7. Spurious radiations

7.7.1. Definition

Spurious radiations from the receiver are components at any frequency. radiated by the equipment and its antenna.

7.7.2. Method of measurement

On a test site, fulfilling the requirements of Clause 5.9., the sample shall be placed at the specified height on the support. The receiver shall be operated from a power source via a radio frequency filter to avoid radiation from the power leads. Radiation of any spurious components shall be detected by the test antenna and receiver.

At each frequency at which a component is detected, the sample shall be rotated to obtain maximum response and the effective radiated power of that component determined by a substitution measurement. The measurement shall be repeated with the test antenna in the orthogonal polarisation plane.

The measurement shall be performed over the frequency range 30 MHz - 4 GHz. In addition. for equipment operating on frequencies above 470 MHz, the measurement may be repeated over the frequency range 4 GHz - 12.5 GHz.

7.7.3. Limits

The effective radiated power of any spurious radiation, on any discrete frequency at either plane or polarisation, shall not exceed 2 nanowatts in the range 100 kHz to 1 GHz. and shall not exceed 20 nanowatts in the range 1 GHz to 12.5 GHz

8. ACCURACY OF MEASUREMENTS

The tolerance for the measurement of the following parameters shall be as given below:

8.1.1.	DC voltage	±3%
8.1.2.	AC mains voltage	±3%
8.1.3.	AC mains frequency	±0.5%
8.2.1.	Audio-frequency voltage, power, etc.	±0.5 dB
8.2.2.	Audio frequency	±1%
81.3.	Distortion and noise, etc. of audio-frequency generators	1%
8.3.1.	Radio frequency	±50 Hz
8.3.2.	Radio-frequency voltage	±2 dB
8.3.	Radio-frequency fieldstrength	±3 dB
8.3.4.	Radio-frequency carrier power (e.r.p.)	±2 dB
8.3.5.	Radio-frequency adjacent channel power	±3 dB
8.4.1.	Impedance of artificial loads, combining units, cables. plugs, attenuators, etc.	±5%
8.4.2.	Source impedance of generators and input impedance of measuring receivers	±10%
8.4.3.	Attenuation of attenuators	±0.5 dB
8.5.1.	Temperature	±1°C
8.5.2.	Humidity	± 5%

Appendix A

GUIDANCE ON THE USE OF RADIATION TEST SITES

For measurements involving the use of radiated fields, use may be made of a test site in conformity with the requirements of paragraph 5.7. of this Annex. When using such a test site, the following conditions should be observed to ensure consistency of measuring results.

A.1. **Measuring distance**

Evidence indicates that the measuring distance is not critical and does not significantly affect the measuring results, provided that the distance is not less than $\lambda/2$ at the frequency of measurement, and the precautions described in this Annex are observed. Measuring distances of 3 m, 5 m, 10 m and 30 m are in common use in the CEPT countries.

A.2. **Test antenna**

Different types of test antenna may be used, since in performing substitution measurements, calibration errors of the test antenna do not affect the measuring results.
Height variation of the test antenna over a range of 1-4 metres is essential in order to find the point at which the radiation is a maximum.
Height variation of the test antenna may not be necessary at the lower frequencies below about 100 MHz.

A.3. **Substitution antenna**

Variations in the measuring results may occur with the use of different types of substitution antenna at the lower frequencies below about 80 MHz. Where a shortened dipole antenna is used at those frequencies, details of the type of antenna used should be included with the results of the tests carried out on the site.

A.4. **Auxiliary cables**

The position of auxiliary cables (power supply and microphone cables. etc.) which are not adequately de-coupled may cause variations in the measuring results. In order to get reproducible results, cables and wires of auxiliaries are mounted vertically downwards through a hole in isolating table or along the simulated man test fixture.

Appendix B

GUIDANCE ON MEASUREMENT FOR THE TRANSIENT BEHAVIOUR OF THE TRANSMITTERS

B. 1. **Definition**

The transient behaviour of the transmitter is determined by the time dependency of transmitter frequency and transmitter power when the transmitter is switched on and off or other switching combinations are used. Within the scope of this specification, it is only the transient behaviour of the transmitter *frequency* which shall be measured.

The following frequency tolerances and transient times are specified:
Δf_0: frequency tolerance in the steady state
Δf_1: frequency difference which may be greater than half the channel separation
Δf_2: frequency difference which must not be greater than half the channel separation
t_1 t_3: period of time during which frequency tolerance Δf_1, applies
t_2: period of time during which frequency tolerance Δf_2: applies

According to the method of measurement described in section B.2., the switch-on instant (t_{on}) of a transmitter is defined by the condition when the output power, measured at the antenna terminal. exceeds 10% of the nominal power. However, this value must not be greater than 100 mW.
The switch-off instant (t_{off}) is given when the nominal power falls below this limit.
Different frequency tolerance schemes have to be applied for the following cases:

B. 1. 1. *Keying criterion when the transmitter is switched on*
The transient times and frequency tolerances are shown in Figure III.B. 1 (T/R 24-0 1)

B.1.2. *Keying criterion when the transmitter is switched off*
The transient time is not subdivided; the frequency tolerance is shown in Figure III.B.2 (T/R 24-01).

B.1.3. *Other switching combinations*
These include all switching processes, such as switching on/off of the radio equipment with simultaneous activation of the transmitter key.

B.2. **Method of measurement**

The transient times (ON/OFF) and the frequency difference occurring during these times can be measured by means of a test discriminator which meets the requirements indicated in Clause B.2.1.
Connect the transmitter with the test set-up as shown in Figure III.B.3 (T/R 24-01). The calibration of the test set-up has to be checked. Operate the transmitter unmodulated in accordance with the operating conditions indicated in Clauses B. 1.1. to B. 1.3. Connect the transmitter output to the input of the test discriminator via a matched test load attenuator. The attenuation of the test load attenuator must be dimensioned in such a way that the input of the test discriminator is protected against overload and the limiter amplifier of the test discriminator operates correctly in the limiting range when the power condition in Clause B.1. is reached.

Prior to each test, the calibration of the test discriminator has to be checked by feeding in RF voltages with defined frequency differences, and the signal generator has to be properly tuned to the nominal frequency of the transmitter.
By appropriate means, generate a triggering pulse either at the instant the transmitter is switched on and off or when the power supply of the radio equipment is switched on and off and the transmitter key is simultaneously pressed.
The voltage occurring at the test discriminator output has to be recorded as a function of time and amplitude on a storage oscilloscope or a transient recorder. The voltage deviation is a measure for the frequency difference. The elapsed time of the frequency transient can be measured by the given time base ranges of the oscilloscope.

B.2.1. *Technical requirements for the test discriminator*
The test discriminator consists of a mixer and local oscillator (auxiliary frequency) to convert the transmitter frequency to be measured into the frequency of the (broadband) limiter amplifier and the following broadband discriminator.
- The effective bandwidth of measuring equipment shall be so wide as to allow frequency differences in the order of 5 times the channel spacing to be resolved exactly;
- the test discriminator must be capable of displaying the frequency deviations sufficiently fast (approx. 100 kHz/100 μs);
- the test discriminator output must be d.c. coupled.

Such combined switching processes may always consist of processes according to Clauses B.1.3. and B.1.2.

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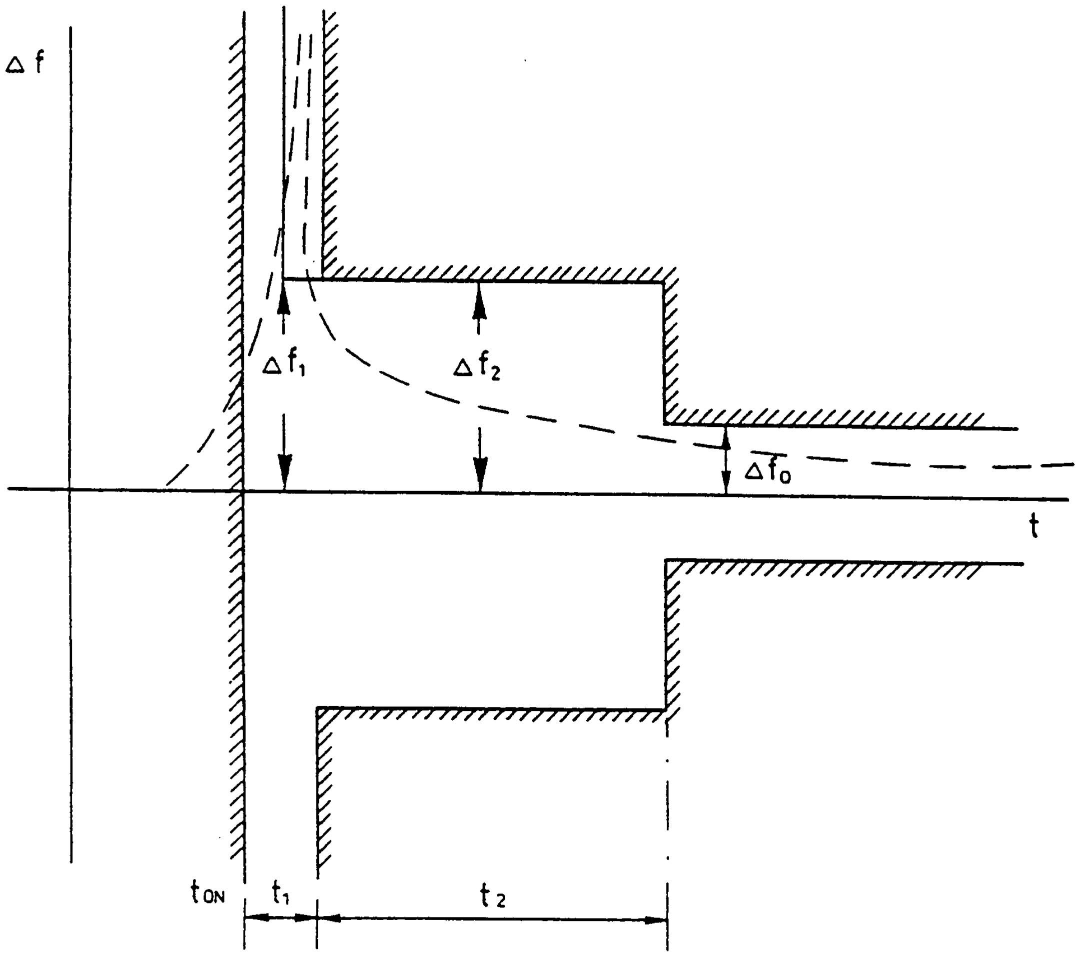

Figure III.B.1 (T/R 24-01). Transient behaviour—in the switch-on position—according to Clauses B.1.1. and B.1.1.3.

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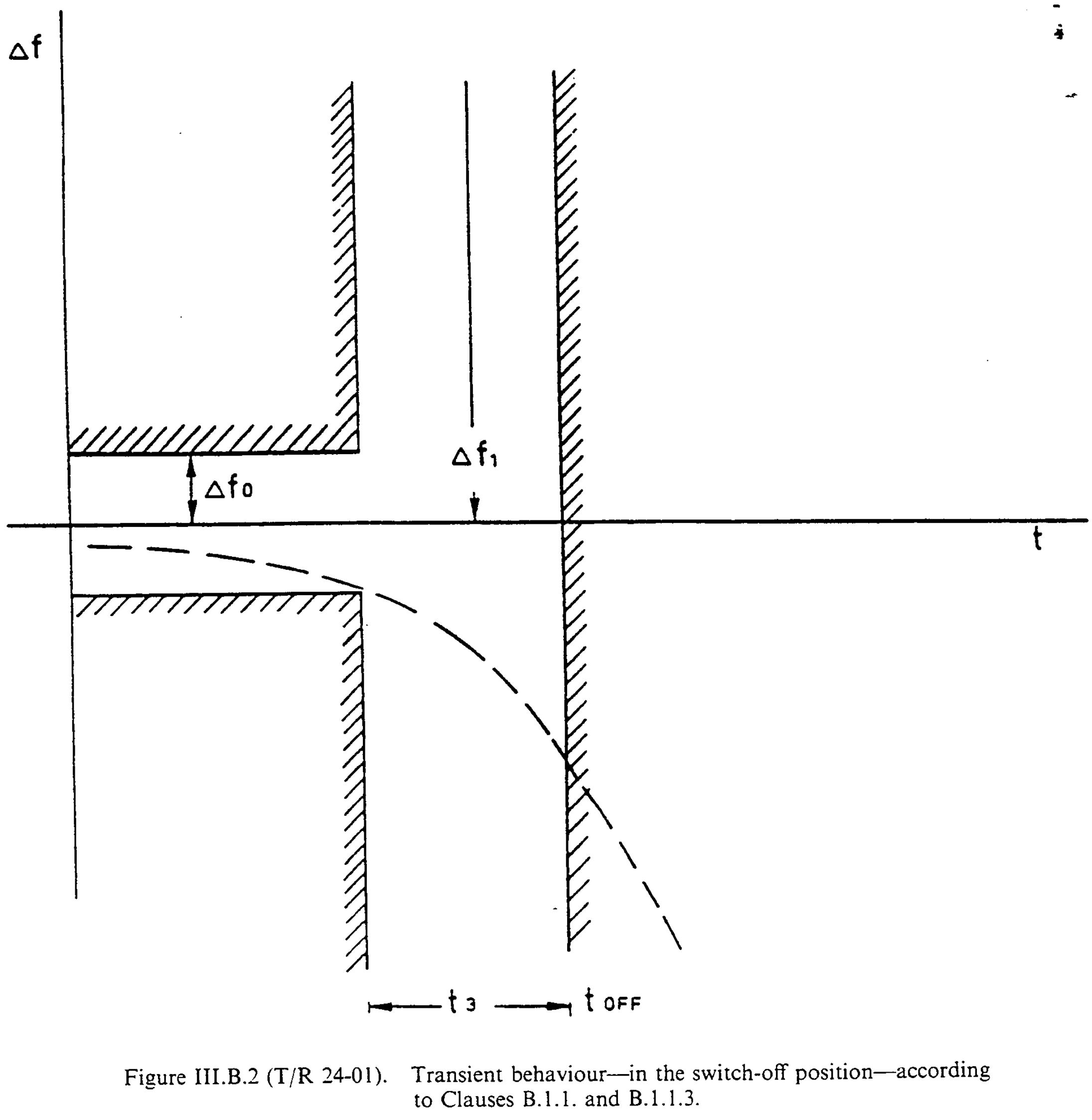

Figure III.B.2 (T/R 24-01). Transient behaviour—in the switch-off position—according to Clauses B.1.1. and B.1.1.3.

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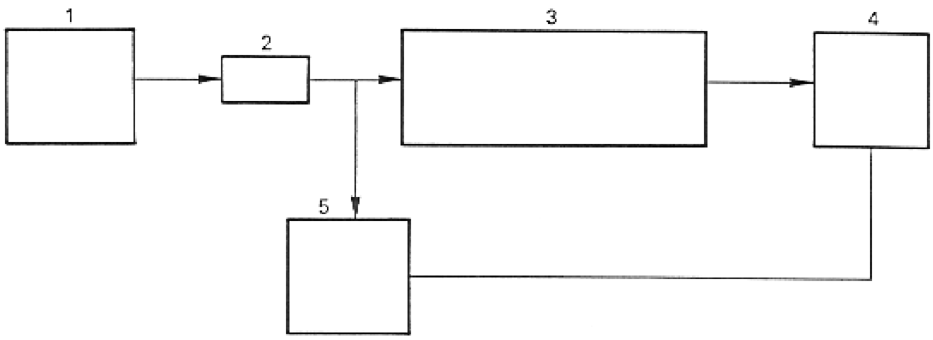

Figure III-B.3 (T/R 24-01). Measuring arrangement for testing the frequency transient behaviour of transmitter.

Legend:

1. Transmitter under test.
2. Test load attenuator.
3. Broadband test discrimination
4. Storage oscilloscope or transient recorder.
5. Transmitter power trigger device.

B.3. **Limits**

The transient times shall not exceed the values given in the table below.

	30-100 MHz	100-300 MHz	300-500 MHz	500-1.000 MHz
t_1 (ms)	5	5	10	20
t_2 (ms)	20	20	25	50
t_3 (ms)	5	5	10	10

Annex IV

Technical characteristics of radio equipment with in built antenna in the land mobile service with regard to quality and stability of transmission

Note. Text approved by the "Telecommunications" Commission at Ostende (1971).

Table of contents

1. SCOPE OF THE SPECIFICATIONS

The specifications of "Technical characteristics and test conditions for radio equipment with in built antenna in the land mobile service" (Annex III) are intended to ensure the optimum utilisation of the frequency spectrum by limiting the extent of radio interference.

This series of specifications should be consulted in conjunction with Annex III; it covers the quality and stability of transmission.

Two types of modulation are considered, phase and frequency modulation. To ensure compatibility, transmitters and receivers operating in the same network must use the same type of modulation.

2. GENERAL CONDITIONS

2.1. References

References to Clauses are to the clauses of Annex III, unless otherwise indicated.

2.2. Impedances

All the radio-frequency and audio-frequency input and output impedance values of the equipment shall be fixed by mutual agreement of the manufacturer and the testing authority.

2.3. Audio-frequency output power

For the purposes of these specifications, the nominal audio-frequency output power of the receiver, as declared by the manufacturer, must be adequate to allow its use in real environmental conditions and should not in any case be less than 200 milliwatts at the loud-speaker *(Note 1)* and 1 milliwatt at the car-piece of the hand-set *(Note 2).*

Notes.

1. Considerably greater output power is required for use in a noisy environment.
2. For a transitional period which shall be determined by each Administration a power level here of only 70 microwatts shall be acceptable.
   Administrations are requested to state the value used in their type-approval test reports.

3. LIMITATION CHARACTERISTIC OF THE TRANSMITTER MODULATOR

3.1. Definition

This characteristic expresses the capability of the transmitter to be modulated with a frequency deviation approaching the maximum permissible deviation specified in Clause 4.3.1.3.

3.2. Method of measurement

The equipment shall be placed in the test chamber (Clause 3.6.).

A modulating signal with a frequency of 1.000 Hz shall be applied to the transmitter. The level (electromotive force) shall be adjusted to produce a frequency deviation equal to 20% of the maximum permissible deviation specified in Clause 4.3.1.3. The level of the modulating signal shall then be raised 20 dB and the deviation measured again.

This test shall be carried out under normal test conditions (Clause 2.3) and under extreme test conditions (Clauses 2.4.1. and 2.4.2. applied simultaneously).

3.3. **Limits**
The frequency deviation should be between 70% and 100% of the maximum permissible deviation.

4. SENSITIVITY OF THE MODULATOR, INCLUDING MICROPHONE

4.1. **Definition**

This characteristic expresses the capability of the transmitter to be satisfactorily modulated when an audio-frequency signal corresponding to the average normal speech level is applied to the microphone.

4.2. **Method of measurement**
An audio-frequency signal of 1.000 Hz shall be applied to the microphone, the loudness level at the diaphragm of the microphone being 94 dB/2 x 10^{-5} Pascal. The deviation produced shall be measured, with the measuring equipment coupled to the transmitter antenna.

Note. Any controls which permit the sensitivity of the modulator to be adjusted should not be accessible to the user.

4.3. **Limit**

The deviation should be between 60% and 90% of the maximum permissible deviation specified in Clause 4.3.1.3.

5. AUDIO-FREQUENCY RESPONSE OF THE TRANSMITTER

5.1. **Definition**
The audio-frequency response of the transmitter expresses the capability of the transmitter to operate without excessive degradation of the frequency response as a function of the modulation frequency.

5.2. **Methods**
Two methods of measurement may be used, which give very similar results. Member Administrations of the CEPT are requested to specify in their type-approval test reports which method or methods have been used.
The equipment shall be placed in a test chamber (Clause 3.6.).

5.2.1. *Constant deviation method*
A modulating signal with a frequency of 1.000 Hz shall be applied to the transmitter. The level (electromotive force) shall be adjusted to produce a frequency deviation equal to 20% of the maximum permissible deviation specified in Clause 4.3.1.3.
The modulating frequency shall then be varied between 300 Hz and 3.000 Hz (300 Hz and 2.550 Hz for transmitters with adjacent channel separation of 12.5 kHz) and the level of the modulating signal adjusted to produce a constant frequency deviation of the radio-frequency signal of the transmitter equal to the value established above.

5.2.1.1. Phase modulation
For a transmitter utilising a pre-emphasis of 6 dB per octave the characteristic giving the amplitude of the audio-frequency modulating signal as a function of the frequency shall vary, within the limits specified below in Clause 5.3.1.1. of Annex IV, by 6 dB per octave from the 1.000 Hz point described above. the amplitude decreasing as the frequency is increased.

5.2.1.2. Frequency modulation
For a transmitter using a constant frequency deviation the amplitude of the audio-frequency modulating signal shall remain constant and equal to its value at 1.000 Hz (as above) as the frequency is varied.

5.2.2. *Constant input level method*
A modulating signal with a frequency of 1.000 Hz shall be applied to the transmitter. The level (electro-motive force) shall be adjusted to produce a frequency deviation equal to 20% of the maximum permissible deviation specified in Clause 4.3.1.3.
The modulating frequency shall then be varied between 300 Hz and 3.000 Hz (300 Hz and 2.550 Hz for transmitters with adjacent channel separation of 12.5 kHz), the level of the audio-frequency signal being maintained constant and equal to the value above.

5.3. Limits

5.3.1. *Constant deviation* method

5.3.1.1. Phase modulation
The amplitude of the audio-frequency modulation signal should not vary from the characteristic given in Clause 5.2.1.1. of Annex IV by more than - 1 dB or + 3 dB.

5.3.1.2. Frequency modulation
The amplitude of the audio-frequency modulation signal should not vary by more than - 1 dB or + 3 dB with respect to its value at 1,000 Hz.

5.3.2. *Constant input level method*

5.3.2.1. Phase modulation
The modulation index (the ratio of the frequency deviation to the modulation frequency) should remain constant and equal to its value at 1,000 Hz within the limits of + 1 dB or - 3 dB.

5.3.2.2. Frequency modulation
The frequency deviation should remain constant and equal to its value at 1.000 Hz within the limits of + 1 dB or -3 dB.

6. HARMONIC DISTORTION RATIO OF THE EMISSION

6.1. Definition
The harmonic distortion ratio of the transmitter when modulated with an audio-frequency signal is defined as the ratio, expressed as a percentage, of the rms voltage of all the harmonic components of the fundamental audio frequency to the total rms voltage of the signal after linear demodulation. In the method described below using a distortion meter, the distortion measured includes the components attributable to hum and noise.

6.2. Method of measurement

The equipment shall be placed in a test chamber (Clause 3.6.).

6.2.1. Phase modulation

The radio-frequency signal produced by the transmitter shall be applied by means of an appropriate coupling device to a linear demodulator equipped with a de-emphasis network of 6 dB per octave.
Under normal test conditions (Clause 2.3.), this radio-frequency signal shall be modulated successively at frequencies of 300 Hz- 500 Hz and 1.000 Hz maintaining a constant modulation index (the modulation index is the ratio of the frequency deviation to the modulation frequency) which at 1.000 Hz produces 60% of the maximum permissible deviation (specified in Clause 4.3.1.3).
The harmonic distortion of the audio-frequency signal shall be measured at each of the frequencies specified above.

Under extreme test conditions (Clauses 2.4.1 and 2.4.2. applied simultaneously), the measurements shall be made at 1,000 Hz with the frequency deviation equal to 70% of the maximum permissible deviation (Clause 4.3.1.3.).

6.2.2. *Frequency modulation*

The radio-frequency signal produced by the transmitter shall be applied by means of an appropriate coupling device to a linear demodulator.
Under normal test conditions (Clause 2.3), the radio-frequency signal shall be modulated successively at 300 Hz, 500 Hz and 1.000 Hz with a frequency deviation equal to 60% of the maximum permissible deviation (Clause 4.3.1.3). The frequency deviation shall be maintained constant at that value. The harmonic distortion of the audio-frequency signal shall be measured at each of the frequencies specified above.
Under extreme test conditions (Clauses 2.4. 1. and 2.4.2. applied simultaneously), the measurements shall be made at 1.000 Hz with a frequency deviation equal to 70% of the maximum permissible deviation (Clause 4.3.1.3).

6.2. **Limits**

The harmonic distortion ratio should not exceed 10%.

7. RESIDUAL MODULATION OF THE TRANSMITTER

7.1. **Definition**

The residual modulation of the transmitter is the ratio, expressed in dB, of the audio-frequency noise power produced after the demodulation of the radio-frequency signal in the absence of any modulation with the wanted signal, by parasitic emissions from the power source, by the modulator or by any other source, to the audio-frequency power produced by the application of the normal test modulation to the transmitter.

7.2 **Method of measurement**

The equipment shall be placed in a test chamber (Clause 3.6.).
The normal test modulation, described in Clause 3.4. shall be applied to the transmitter. The high-frequency signal produced by the transmitter shall be applied by means of an appropriate coupling device to a linear demodulator.
For phase modulation the demodulator shall be equipped with a de-emphasis network of 6 dB per octave. Every precaution must be taken to ensure that the measurements are not falsified by the emphasis of the internal noise of the linear demodulator at low audio frequencies.

The signal shall be measured at the demodulator output with an rms voltmeter equipped with a psophometric filtering network such as described in CCITT Recommendation P.53A.
The modulation shall then be switched off and the residual audio-frequency signal at the output terminal measured.

7.3. **Limit**

Residual modulation should not exceed -40 dB.

8. AUDIO-FREQUENCY RESPONSE OF THE RECEIVER

8.1. **Definition**

The receiver response expresses the variations in the audio-frequency output level of the receiver as a function of the modulation frequency of the high-frequency input signal.

8.2. **Method of measurement**

The equipment shall be placed in a test chamber (clause 3.6).
A test signal at the same frequency as the nominal frequency of the receiver shall be applied to the input of the test chamber, respecting the conditions specified in Clause 3.1. Its level shall be 50 dB higher than the Z dB/1 μV level (see Clauses 5.1.2.2. and 5.1.2.3.) which gives a ratio, in the test chamber, of S + N + D/N+ D or S + N+ D/N of 20dB.
The receiver's audio-frequency power control must be adjusted to provide a power level not less than 50% of the nominal output power (Clause 2.3., Annex IV) when the normal test modulation is applied in accordance with Clause 3.4. This setting shall not be altered again during the course of this test.
The frequency deviation at 1.000 Hz shall then be reduced to 20% of the maximum permissible deviation. The deviation shall be maintained constant while the modulation frequency is varied between 300 Hz and 3.000 Hz (300 Hz and 2.550 Hz for receivers with adjacent channel separation of 12.5 kHz).
The procedure shall be repeated with a test signal at the same frequency as the nominal frequency of the receiver plus or minus half the absolute frequency tolerance value for the corresponding transmitter given by Table I of Clause 4.1.3.

8.3. **Limits**

8.3.1. *Phase modulation*

For a receiver having a de-emphasis of 6 dB per octave, the characteristic giving the amplitude of the audio-frequency output level varies by 6 dB per octave from the 1.000 Hz point described above. the amplitude decreasing as the frequency is increased.
The audio-frequency output level of the receiver should not vary from this characteristic by more than + 1 dB or -3 dB.

8.3.2. *Frequency modulation*

The audio-frequency output level for the reception of constant frequency deviation transmissions should remain equal to its value at 1.000 Hz as the frequency is varied. within the following limits.
The audio-frequency output level of the receiver should remain within + 1 dB or - 3 dB of its value at 1.000 Hz.

9. HARMONIC DISTORTION

9.1. Definition

The harmonic distortion ratio at the receiver output is defined as the ratio, expressed as a percentage. of the rms voltage of all the harmonic components of the fundamental audio frequency to the total rms voltage of the signal delivered by the receiver.
In the method of measurement described below, using a distortion meter, the components attributable to hum and to noise are included in the distortion measurement.

9.2. Methods of measurement

The equipment shall be placed in a test chamber (Clause 3.6.).
A test signal at the same frequency as the nominal frequency of the receiver shall be applied to tile input of the test chamber, respecting the conditions specified in Clause 3. 1. On a first measurement. its level shall be 50 dB higher and. on a second measurement, 90 dB higher than the Z dB/1 µV level (see Clauses 5.1.2.2. and 5.1.2.2) which gives a ratio, in the test chamber, of S + N + D/N + D or S + N + D/N of 20 dB. For each test the receiver's audio-frequency power control must be adjusted so as to obtain the nominal output power (Clause 2.3., Annex IV) for a resistive load which simulates the receiver's operating load. In the case of a stepped power control it must be set at the first position which gives an output power level not lower than the nominal output power.

9.2.1. *Phase modulation*

Under normal conditions the test signal shall be modulated successively at 300 Hz, 500 Hz and 1,000 Hz maintaining a constant modulation index (ratio of frequency deviation to modulation frequency). For a modulation frequency of 1,000 Hz the modulation index must give a frequency deviation which is 60% of the maximum permissible deviation (Clause 4.3.1.3).
The harmonic distortion shall be measured at each of the above frequencies.
Under extreme test conditions (Clauses 2.4.1. and 2.4.2. applied simultaneously) the tests shall be made at the receiver's nominal frequency and at the nominal frequency plus and minus half the absolute value of the frequency tolerance for the corresponding transmitter (given by Table I of Clause 4.1.3).
The modulation frequency for these tests shall be 1.000 Hz and the frequency deviation equal to 70% of the maximum permissible deviation.

9.2.2. *Frequency modulation*

Under normal conditions the test signal shall be modulated successively at 300 Hz, 500 Hz and 1,000 Hz with a frequency deviation equal to 60% of the maximum permissible deviation (Clause 4.3.1.3.).
The harmonic distortion shall be measured at each of the above frequencies.
Under extreme test conditions (Clauses 2.4.1. and 2.4.2. applied simultaneously) the tests shall be made at the receiver's nominal frequency and at the nominal frequency plus and minus half the absolute value of the frequency tolerance for the corresponding transmitter (given by Table I of Clause 4.1.3.).
The modulation frequency for these tests shall be 1.000 Hz and the frequency deviation equal to 70% of the maximum permissible deviation.

9.3. **Limit**

The harmonic distortion at each audio frequency and under all the test conditions should not exceed 10%.

10. **RECEIVER "HUM AND NOISE"**

10.1. **Definition**

The “hum and noise” of the receiver is the ratio, expressed in dB. of the audio-frequency power of the noise and hum produced by the parasitic emissions of the power source or by any other source to the audio-frequency power of a high-frequency signal modulated by the normal test modulation applied at the receiver input.

10.2. **Method of measurement**

The equipment shall be placed in a test chamber (Clause 3.6.).
A test signal whose carrier frequency is the same as the nominal frequency of the receiver, modulated by the normal test modulation specified by Clause 3.4., shall be applied to the input of the test chamber, respecting the conditions specified in Clause 3.1. Its level shall be 25 dB higher than the Z dB/1 μV level (see Clauses 5.1.2.2. and 5.1.2.3.) which gives a ratio, in the test chamber, of S + N + D/N + D or S + N + D/N of 20 dB. An audio-frequency load (see Clause 3.3.), and a psophometric filtering network (Clause 5.1.1.2.), shall be substituted for the receiver's loudspeaker. If the audio-frequency power control is of a continuous type, it shall be set to supply not less than the nominal output power (Clause 2.3., Annex IV), and in the case of a stepped power control, set to the first position which gives a power level not lower than the nominal power.
The output signal shall be measured using an rms voltmeter.
The modulation shall then be switched off and the audio-frequency output level measured again.

10.3. **Limit**

The ratio of the “noise and hum” level of the receiver to the level of the modulation signal should not exceed - 40 dB.

Annex V

Technical characteristics and test conditions for non-speech and combined speech /non -speech radio equipment (using signalling to initiate a specific response in the receiver) in the land mobile service

Table of contents

1. SCOPE OF THE SPECIFICATIONS

These technical specifications cover the minimum characteristics considered necessary in order to make the best use of the available frequencies. They do not necessarily include all the characteristics which may be required by a user, nor do they necessarily represent the optimum performance achievable. They apply to non-speech and combined speech/non-speech radio systems using frequency modulation or phase modulation as chosen by each Administration for the land mobile service, operating on radio frequencies between 30 MHz and 1,000 MHz. wit channel separations of 12.5 kHz, 20 kHz and 25 kHz.
In these specifications, non-speech systems are defined as systems employing signalling to initiate a specific response in the receiver. The equipment shall comprise a transmitter and associated encoder and/or a receiver and associated decoder. Additional specifications or amendments are required for equipment with integral antennas. Additional specifications or amendments may be required for equipment such as that:

- intended for connection to public telephone network;
- using other types of modulation;
- for portable use including pocket sized equipment.

In these specifications different requirements are given for the different radio frequency bands, channel separations, etc., where appropriate.
If, in case of combined speech/non-speech equipment, the speech part of the system is tested according to Annex I, only the tests described in Clauses 4.3. and 5.1. of this Annex shall be carried out.

2. TEST CONDITIONS, POWER SOURCES AND AMBIENT TEMPERATURES

2.1. Normal and extreme test conditions

Type approval tests shall be made under normal test conditions, and also, where stated, under extreme test conditions.
The test conditions and procedures shall be as specified in Clauses 2.2. to 2.5.

2.2. Test power source

During type approval tests the power source of the equipment shall be replaced by a test power source. capable of producing normal and extreme test voltages as specified in Clauses 2.3.2. and 2.4.2. The internal impedance of the test power source shall be low enough for its effect on the test results to be negligible.
For the purpose of tests. the voltage of the power source shall be measured at the input terminals of the equipment.
If the equipment is provided with a permanently connected power cable, the test voltage shall be that measured at the point of connection of the power cable to the equipment.
In equipment with incorporated batteries the test power source shall be applied as close to the battery terminals as practicable.
During tests, the power source voltages shall be maintained within a tolerance of ± 3% relative to the voltage at the beginning of each test.

2.3. Normal test conditions

2.3.1. *Normal temperature and humidity*

The normal temperature and humidity conditions for tests shall be any convenient combination of temperature and humidity within the following ranges:
Temperature: + 15° C to +35° C
Relative humidity: 20% to 75%
Note. When it is impracticable to cart, out the tests under the conditions stated above. a note to this effect, stating the actual temperature and relative humidity during the tests. shall be added to the test report.

2.3.2. *Normal test power source*

2.3.2.1. Mains voltage

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of these specifications. the nominal voltage shall be the declared voltage or any of the declared voltages for which the equipment was designed.

2.3.2.2. Regulated lead-acid battery power sources on vehicles
When the radio equipment is intended for operation from the usual types of regulated lead-acid battery power sources on vehicles, the normal test voltage shall be 1.1 times the nominal voltage of the battery (6 volts, 12 volts, etc.).

2.3.2.3. Other power sources
For operation from other sources or types of battery (primary or secondary), the normal test voltage shall be that declared by the equipment manufacturer.

2.4. Extreme test conditions

2.4.1. *Extreme temperatures*
For tests at extreme temperatures, measurements shall be made in accordance with the procedures specified in Clause 2.5. at the upper and lower temperatures of one of the following ranges:
-25° C to + 55° C
-20° C to + 55° C
-10° C to + 55° C
Type approval test reports should state which range is applicable

2.4.2. *Extreme test source voltages*

2.4.2.1. Mains voltage
The extreme test voltage for equipment to be connected to an AC mains source shall be the nominal mains voltage :± 10%.

2.4.2.2. Regulated lead-acid battery power sources on vehicles
When the equipment is intended for operation from the usual types of regulated lead-acid battery power sources on vehicles the extreme test voltages shall be 1.3 and 0.9 times the nominal voltage of the battery (6 volts, 12 volts. etc.).

2.4.2.3. Other power sources
The lower extreme test voltage for equipment with power sources using primary batteries shall be as follows:
1. for the Leclanché- or the lithium-type of battery:
   0.85 times the nominal voltage of the battery;
2. for the mercury-type of battery:
   0.9 times the nominal voltage of the battery;
3. for other types of primary batteries:
   end point voltage declared by the equipment manufacturer.

For equipment using other power sources, or capable of being operated from a variety of power sources, the extreme test voltages shall be those agreed between the equipment manufacturer and the testing authority and shall be recorded with the results.

2.5. Procedure for tests at extreme temperatures

2.5.1. *Test procedure*
Before measurements are made the equipment shall have reached thermal balance in the test chamber. The equipment shall be switched off during the temperature stabilising period'). If the thermal balance is not checked by measurements, a temperature stabilising period of at least one hour, or such period as may be decided by the testing authority, shall be allowed. The sequence of measurements shall be chosen, and the humidity contents in the test chamber shall be controlled so that excessive condensation does not occur.

2.5.1.1. Procedure for equipment designed for continuous operation
If the manufacturer states that the equipment is designed for continuous operation, the test procedure shall be as follows:

[1]) In the case of equipment containing temperature stabilisation circuits designed to operate continuously, the temperature stabilisation circuits is maybe switched on for 15 minutes after thermal balance has been obtained and the equipment shall then meet the specified requirements. For such equipment the manufacturer shall provide for the power source circuit feeding the crystal even to be independent of the power source to the rest of the equipment.

Before tests at the upper temperatures the equipment shall be placed in the test chamber and left until thermal balance is attained[1]). The equipment shall then be switched on in the transmit condition for a period of half an hour after which the equipment shall meet the specified requirements. For tests at the lower temperatures the equipment shall be left in the test chamber until thermal balance is attained[1]), then switched to the stand-by or receive condition for one minute after which the equipment shall meet the specified requirements.

2.5.1.2. Procedure for equipment designed for intermittent operation

If the manufacturer states that the equipment is designed for intermittent operation, the test procedure shall be as follows:
Before tests at the upper temperatures the equipment shall be placed in the test chamber and left until thermal balance is attained[1]). The equipment shall then be switched on for one minute in the transmit condition, followed by four minutes in the receive condition, after which the equipment shall meet the specified requirements. For tests at the lower temperatures, etc. (as above).

3. GENERAL CONDITIONS

3.1. Arrangements for test signals applied to the receiver input

Sources of test signals for application to the receiver shall be connected in such a way that the impedance presented to the receiver input is 50 ohms.
This requirement shall be met irrespective of whether one or more signals are applied to the receiver simultaneously.
The levels of the test signals shall be expressed in terms of the e.m.f. at the receiver input terminals. The effects of any intermodulation products and noise produced in the signal generators should be negligible.

3.2. Facilities for access between the receiver and decoder

In order to simplify the measurement in Clause 5.4. a possibility of access between the receiver access and the decoder input shall be provided.

3.3. Encoder for receiver measurements

In order to simplify the measurement in Clause 5.4. a possibility of access between the receiver access and the decoder input shall be provided.

3.4 Definitions

3.4.1. *Normal coded test signal*

The normal coded test signals shall be trains of correctly coded signals, separated from each other by a time of not less than the reset time of the receiver. This signal shall be that. as agreed between the manufacturer and testing authority. which requires the greatest radio frequency occupied bandwidth. Details of this test signal shall be included in the test report.
The encoder, which is associated with the transmitter, shall be capable of supplying the normal coded test signal. If possible this should be continuous modulation for the duration of the measurements.

[1]) In the case of equipment containing temperature stabilisation circuits designed to operate continuously, the temperature stabilisation circuits may be switched on for 15 minutes after thermal balance has been obtained and the equipment shall then meet the specified requirements. For such equipment the manufacturer shall provide for the power source circuit feeding the crystal even to be independent of the power source to the rest *of* the equipment.

3.4.2. *Calling indicator*
Any suitable means of indicating that the receiver has responded to a correctly coded input signal may be used.

3.4.3. *Reset*
The reset may be a manual or automatic method of cancelling the calling indication and resetting the decoder enabling it to respond to the next correctly coded input signal.

3.4.4. *Reset time*
The reset time of the receiver is the minimum elapsed time between two calls in order that they may both be successfully registered. The reset time shall be declared by the manufacturer in order that the formation of a normal coded test signal may be derived.

3.5. **Transmitter artificial antenna**
Tests on the transmitter shall be carried out with a non-reactive, non-radiating load of 50 ohms connected to the antenna terminals.

3.6. **Tests of equipment with a duplex filter**
It the equipment is provided with a built-in duplex filter or a separate associated filter, the requirements of these specifications shall be met when the measurements are carried out using the antenna terminals of this filter.

3.7. **Test site and general arrangements for measurements involving the use of radiated fields**

3.7.1. *Test site*

The test site shall be on a reasonably level surface or ground.
At one point on the site, a ground plane of at least 5 metres diameter shall be provided. In the middle of this ground plane, a non-conducting support, capable of rotation through 360° in the horizontal plane, shall be used to support the test sample at 1.5 metres above the ground plane.

The test site shall be large enough to allow the erection of a measuring or transmitting antenna at a distance of $\lambda/2$ or 3 metres whichever is the greater. The distance actually used shall be recorded with the results of the test carried out on the site. Sufficient precautions shall be taken to ensure that reflections from extraneous objects adjacent to the site and ground reflections do not degrade the measurement results- A guidance on the use of radiation test sites is given in Appendix A/V.

3.7.2. *Test antenna*
The test antenna is used to detect the radiation from both the test sample and the substitution antenna, when the site is used for radiation measurements; where necessary, it is used as a transmitting antenna, when the site is used for the measurement of receiver characteristics. This antenna is mounted on a support such as to allow the antenna to be used in either the horisontal or vertical polarisation and for the height of its centre above ground to be varied over the range 1.5 metres. Preferably test antennae with pronounced directivity should be used. The size of the test antenna along the measurement axis shall not exceed 20% of the measuring distance.

For radiation measurements, the test antenna is connected to a test receiver, capable of being tuned to any frequency under investigation and of measuring accurately the relative levels of signals at its input. When necessary (for receiver measurements) the test receiver is replaced by a signal source.

3.7.3. *Substitution antenna*
The substitution antenna shall be a $\lambda/2$ dipole, resonant at the frequency under consideration, or a shortened dipole. calibrated to the $\lambda/2$ dipole. The centre of this antenna shall coincide with the reference point of the test sample it has replaced. This reference point shall be the volume centre of the sample when its antenna is mounted inside the cabinet, or the point where an external antenna is connected to the cabinet.

The distance between the lower extremity of the dipole and the ground shall be at least 30 cm.

The substitution antenna shall be connected to a calibrated signal generator when the site is used for radiation measurement and to a calibrated measuring receiver when the site is used for measurement of receiver characteristics.

The signal generator and the receiver shall be operating at the frequencies under investigation and shall be connected to the antenna through suitable matching and balancing networks.

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3.7.4. *Alternative indoor site*

When the frequency of the signals being measured is greater than 80 MHz, use may be made of an indoor site. If this alternative site is used, this shall be recorded in the test report.

The measurement site may be a laboratory room with a minimum area of 6 metres by 7 metres and at least 2.7 metres in height.

Apart from the measuring apparatus and the operator, the room shall be as free as possible from reflecting objects other than the walls, floor and ceiling.

The site arrangement is in principle shown in Figure V.1 (T/R 24-01).

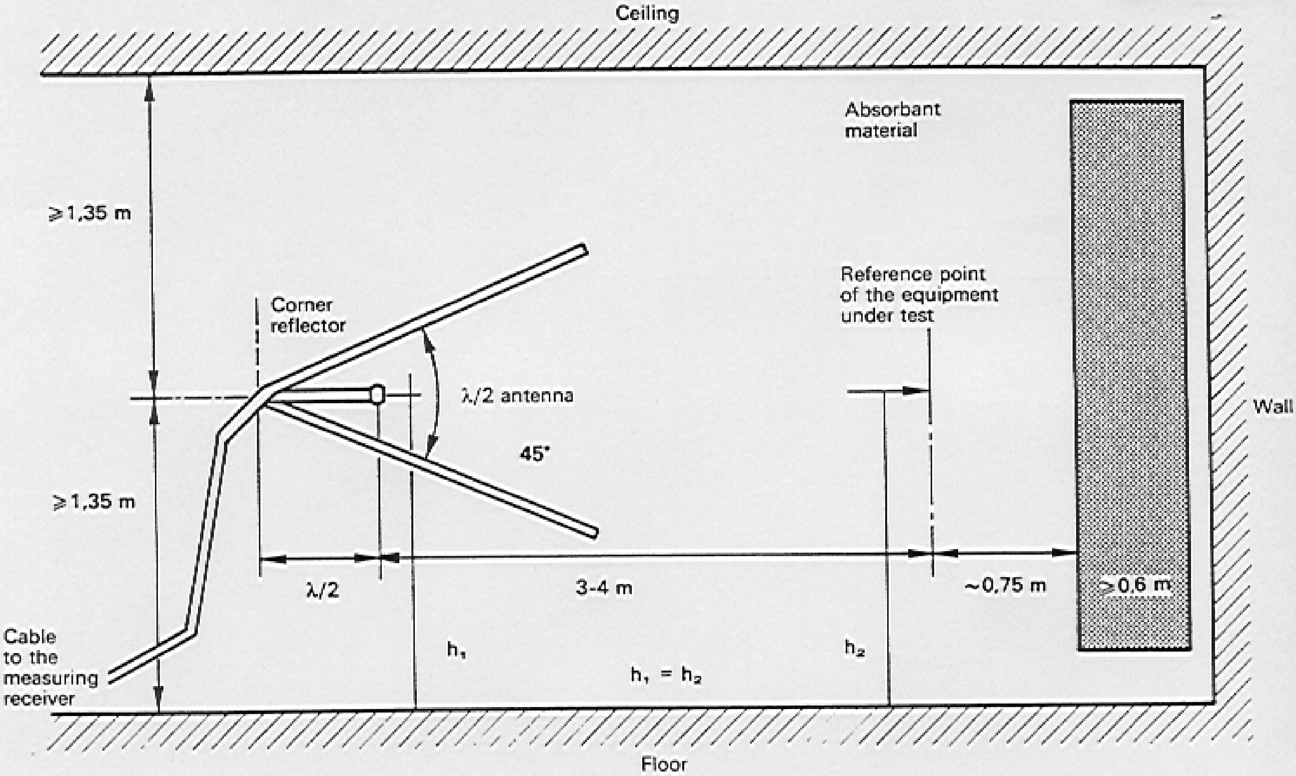

Figure V.1 (T/R 24-01). Indoor site arrangement (shown for horizontal polarisation).

The potential reflections from the wall behind the equipment under test are reduced by placing a barrier of absorbent material in front of it. The corner reflector around the test antenna is used to reduce the effect of reflections from the opposite wall and from the floor and ceiling in the case of horizontally polarised measurements.

Similarly, the corner reflector reduces the effects of reflections from the side walls for vertically polarised measurements.

For the lower part of the frequency range (below approximately 175 MHz) no corner reflector or absorbent barrier is needed.

For practical reasons, the λ/2 antenna in Figure V.1 (T/R 24-01) may be replaced by an antenna of constant length, provided that this length is between λ/4 and λ at the frequency of measurement, and the sensitivity of the measuring system is sufficient. In the same way the distance of λ/2 to the apex may be varied.

The test antenna, test receiver, substitution antenna and calibrated signal generator are used in a way similar to that of the general method.

To ensure that errors are not caused by the propagation path approaching the point at which phase cancellation between direct and the remaining reflected signals occurs, the substitution antenna shall be moved through a distance of ± 10 cm in the direction of the test antenna as well as in the two directions perpendicular to this first direction. If these changes of distance cause a signal change of greater than 2 dB, the test sample should be resited until a change of less than 2 dB is obtained.

3.8. **Unmodulated operation of the transmitter**

For the purpose of the measurements according to this Recommendation there should be a facility to operate the transmitter in an unmodulated state.

4. TRANSMITTER

4.1. Frequency error

4.1.1. Definition

The frequency error of the transmitter is the difference between the measured carrier frequency and its nominal value.

4.1.2 *Method of measurement*

The carrier frequency shall be measured in the absence of modulation with the transmitter connected to an artificial antenna (Clause 3.5.). The measurement shall be made under normal test conditions (Clause 2.3.) and extreme test conditions (Clauses 2.4.1. and 2.4.2. applied simultaneously).

4.1.3 *Limits*

The frequency error shall not exceed the values given in TableV.1 (T/R 24-01). in both normal and extreme test conditions, or in any intermediate set of conditions.

Channel separation (kHz)	Frequency tolerance (kHz)				
	Below	50 MHz	50 to 100 MHz	300 to 500 MHz	500 to 1.000 MHz
20 and 25	± 0.6	± 1.35	± 2.0	± 2.5	± 2.5 (c)
12.5	± 0.6	± 1.9 (a)	± 1.0 (a) (B) ± 1.5 (a) (M)	± 1.0 (b) (B) ± 1.5 (b) (c) (M)	No value specified

Table V.1 (T/R 24-0 1).

(a) Even tighter tolerances are desirable.
(b) The tolerances shown in the table are tentative.
(c) For portable equipments having integral power supplies, the tolerances given shall not be exceeded over a temperature range of 0-30° C. Under extreme temperature conditions (Clause 2.4.1.) the frequency error shall not exceed:
± 2.5 kHz for equipment employing 12.5 kHz channel separation in the frequency range 300-500 MHz
± 3.0 kHz for equipment employing 25 kHz channel separation in the frequency range 500-1.000 MHz.
(B) = Base station. (M) = Mobile station.

4.2. Carrier power

It is assumed that Administrations will state the maximum permitted value of effective radiated power; this could be a condition for issuing the licence.

4.2.1. *Definition*

The transmitter carrier power is the mean power delivered to the artificial antenna during a radio frequency cycle. without modulation.
The rated output power is the carrier power declared by the manufacturer.

4.2.2. *Method of measurement*

The transmitter shall be connected to an artificial antenna (Clause 3.5.), and the power delivered to this artificial antenna shall be measured.
The measurements shall be made under normal test conditions (Clause 2.1) and extreme test conditions (Clauses 2.4.1. and 2.4.2. applied simultaneously).

4.2.3. Limits

The carrier output power under normal test conditions shall be within ± 1.5 dB of the rated output power. The carrier output power under extreme test conditions shall be within + 2 dB and - 3 dB of the rated output power.

Note 1. If the equipment is designed to operate with different carrier powers, the rated power for each power level or range of levels must be declared by the manufacturer. The power adjustment control shall not be accessible to the user. *Note 2.* The requirements *of* this specification must be met for all power levels at which the transmitter can operate.

4.3. Adjacent channel

4.3.1. *Definition*

The adjacent channel power is that part of the total power output of a transmitter under defined conditions of modulation, which falls within a specified passband centred on the nominal frequency of either of the adjacent channels. This power is the sum of the mean power produced by the modulation, hum and noise of the transmitter.

4.3.2 *Methods of measurement*

4.3.2.1. General remarks

Two methods are proposed, the results of which are equivalent. Administrations are requested to use one or both methods. The method applied should be stated in the test report.

4.3.2.2. Method of measurement using a power measuring receiver

The adjacent channel power may be measured with a power measuring receiver, which conforms to Clause 4.3.2.3. (referred to in Clauses 4.3.2.2. and 4.3.2.3. as the “receiver”

(a) The transmitter shall be operated at the carrier power determined in Clause 4.2. under normal test conditions (Clause 2.3.). The output of the transmitter shall be linked to the input of the “receiver” by a connecting device such that the impedance presented to the transmitter is 50 ohms and the level at the “receiver” input is appropriate.

(b) With the transmitter unmodulated[2]), the tuning of the “receiver” shall be adjusted so that a maximum response is obtained. This is the 0 dB response point. The "receiver" attenuator setting and the reading of the meter shall be recorded.

(c) The tuning of the “receiver” shall be adjusted away from the carrier so that the “receiver” -6 dB response nearest the transmitter carrier frequency is located at a displacement from the nominal carrier frequency as given in the following table:

Channel spacing (kHz)	Specified necessary Bandwidth (kHz)	Displacement of the 6 dB point
25	16	17
20	14	13
12.5	8.5	8.25

Table V-2 (T/R 24-01)

(d) The transmitter shall be modulated with the normal coded test signal (Clause 3.4.l.). If possible this should be continuous modulation for the duration of the measurement.

(c) The "receiver" variable attenuator shall be adjusted to obtain the same meter reading as in step (b) or a known relation to it.

(f) The ratio of adjacent channel power is the difference between the attenuator settings in steps (b) and (c), corrected for any differences in the reading of the meter.

(g) The measurement shall be repeated with the "receiver" tuned to the other side of the carrier.

[2]) The measurement may be made with the transmitter modulated with the normal coded test signal (Clause 3.4.1.). in which case this fact shall be recorded along with the measurement results.

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4.3.2.3. Power measuring receiver specification

The power measuring receiver consists of a mixer, an IF-filter, an oscillator, an amplifier, a variable attenuator and an rms value indicator. Instead of the variable attenuator with the rms value indicators it is also possible to use a dB-calibrated rms voltmeter. The technical characteristics of the power measuring receiver are given below:

4.3.2.3.1. IF-filter

The IF-filter shall be within the limits of the following selectivity characteristic.

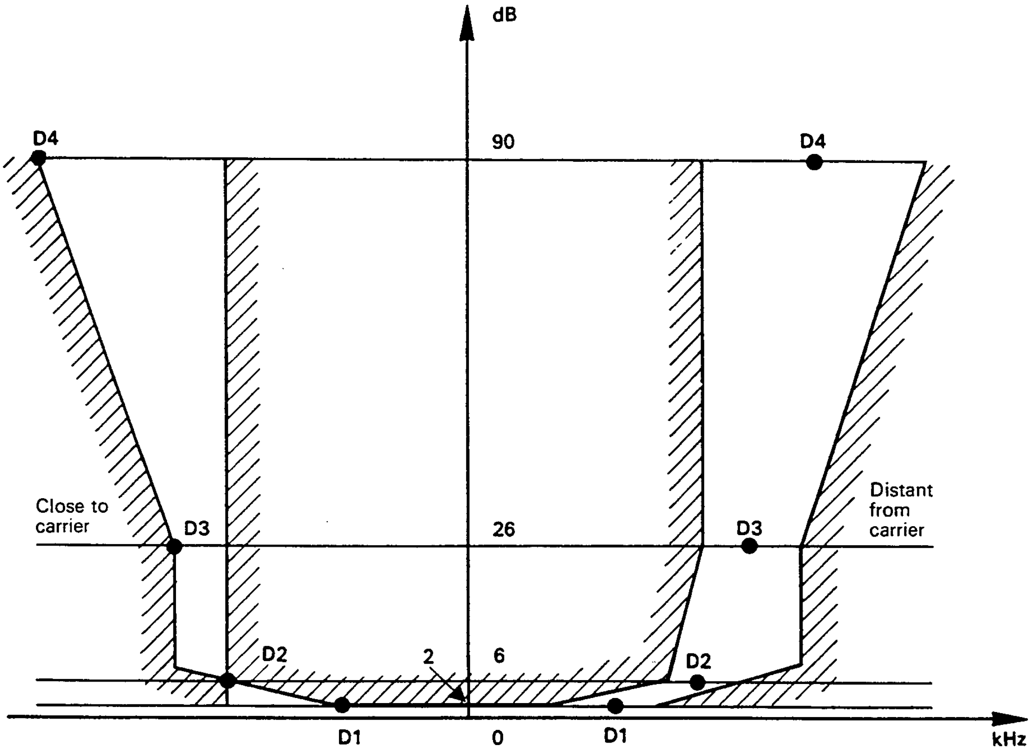

Figure V.2 (T/R 24-01).

Depending on the channel spacing, the selectivity characteristic shall keep the following frequency separations from the nominal centre frequency of the adjacent channel:

Channel spacing (kHz)	Frequency separation of filter curve from nominal centre frequency of adjacent channel (kHz)			
	D1	D2	D3	D4
12.5	3	4.25	5.5	9.5
20	4	7.0	8.25	12.25
25	5	8.0	9.25	13.25

Table V.3 (T/R 24-01).

Depending on the channel spacing, the attenuation points shall not exceed the following tolerances:

Channel spacing (kHz)	Tolerance range (kHz)			
	D1	D2	D3	D4
12.5	+1.35	±0.1	−1.35	−5.35
20	+3.1	±0.1	−1.35	−5.35
25	+3.1	±0.1	−1.35	−5.35

Table V.4 (T/R 24-01). Attenuation points close to carrier.

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Channel spacing (kHz)	Tolerance range (kHz)			
	D1	D2	D3	D 4
12.5	± 2.0	± 2.0	± 2.0	± 2.0 - 6.0
20	± 3.0	± 3.0	± 3.0	+ 3.0 - 7.0
25	± 3.5	± 3.5	± 3.5	+ 3.5 -7.5

Table V.5 (T/R 24-01). Attenuation points distant from carrier.

The minimum attenuation of the filter outside the 90 dB attenuation points must be equal to or greater than 90 dB.

4.3.2.3.2. Attenuation indicator

The attenuation indicator shall have a minimum range of 80 dB and a reading accuracy of 1 dB. With a view to future regulations an attenuation of 90 dB or more is recommended,

4.3.2.3.3. Rms value indicator

The instrument shall accurately indicate non-sinusoidal signals in a ratio of 10: 1 between peak value and rms value.

4.3.2.3.4. Oscillator and amplifier

The oscillator and the amplifier shall be designed in such a way that the measurement of the adjacent channel power of a low-noise unmodulated transmitter, whose self-noise has a negligible influence on the measurement result, yields a measured value of ≤ -90 dB for a channel spacing of 20 and 25 kHz and of ≤ - 80 dB for a channel spacing of 12.5 kHz referred to the carrier of the oscillator.

4.3.2.4. Method of measurement using a spectrum analyser

The adjacent channel power may be measured with a spectrum analyser which conforms to Clause 4.3.2.5. The transmitter shall be operated at the carrier power determined in Clause 4.2. under normal test conditions (Clause 2.3.). The output of the transmitter shall be linked to the input of a spectrum analyser by a connecting device such that the impedance presented to the transmitter is 50 ohms and the level at the spectrum analyser input is appropriate. The transmitter shall be modulated by the norm al coded test signal.

If possible this should be continuous modulation for the duration of the measurement.
The spectrum analyser shall be so adjusted that the spectrum of the transmitter output, including that part which lies within the adjacent channels, is displayed.

For the purpose of this test, the bandwidth of a receiver of the type normally used in the system shall be taken to be:
(a) 16 kHz for 25 kHz channel separation;
(b) 14 kHz for 20 kHz channel separation;
(c) 8.5 kHz for 12.5 kHz channel separation,
with a tolerance of ± 10%.

The centre frequency of the bandwidth within which measurements are to be made shall have a separation from the nominal carrier frequency of the transmitter equal to the channel separation for which the equipment is intended.

The adjacent channel power is the sum of the power of each of the discrete components and of the noise in the appropriate bandwidth. This sum may be calculated or an automatic power level integrating device may be used to obtain it (see Clause 4.3.2.6.).
In the latter case, the relative power level of the carrier and its sidebands are initially measured by integration in the appropriate bandwidth, centred on the nominal frequency. The integration is repeated at this bandwidth centred on the nominal frequency of the adjacent channel and the input level of the carrier signal increased until the same power level at the output of the device is obtained.
The difference in the input levels, in dB, is the ratio of the adjacent channel power to the carrier output power.

The adjacent channel power, expressed as an effective radiated power, is calculated by applying this ratio to the carrier output power as determined in Clause 4.2. or by a direct substitution method using_a calibrated source.

The measurement shall be repeated for the other adjacent channel.

4.3.2.5. Spectrum analyser specification

The specification shall include the following requirements:

It shall be possible, using a resolution bandwidth of 1 kHz, to measure the amplitude of a signal or noise at a level 3 dB or more above the noise level of the spectrum analyser, as displayed on the screen, to an accuracy of ± 2 dB in the presence of a signal separated in frequency by:

(a) 10 kHz, at a level 90 dB above that of the signal to be measured for 25 and 20 kHz channel separations. and

(b) 6.25 kHz, at a level 80 dB above that of the signal to be measured for a 12.5 kHz channel separation.

The reading accuracy of the frequency marker shall be within ± 2% of the channel separation.
The accuracy of relative amplitude measurements shall be within ± 1 dB.
It shall be possible to adjust the spectrum analyser so that two components with a frequency difference of 1 kHz are displayed separately.

4.3.2.6. Integrating and power summing device

The integrating and power summing device is connected to the video output of the spectrum analyser, described in Clause 4.3.2.5.
It shall be possible to summate the effective power of all discrete components and the noise power in the selected.bandwidth and to measure this as a ratio to the carrier power.
The position and the width of the integration range selected can be indicated on the spectrum analyser by brightening the trace.
When power levels as low as 50 nanowatts are measured, the output of the device should exceed the internal noise level by at least 10 dB. The dynamic range shall permit measurement of the values required under Clause 4.3.3. with a margin of at least 10 dB.

4.3.3. *Limits*

For channel separations of 20 kHz and 25 kHz the adjacent channel power shall not exceed a value of 70 dB below the carrier power of the transmitter without any need to descend below 0.2 microwatt. For channel separations of 12.5 kHz, the adjacent channel power shall not exceed a value of 60 dB below the transmitter carrier power without any need to descend below 0.2 microwatt.

4.4. **Spurious emissions**

4.4.1. *Definition*

Spurious emissions are emissions at frequencies other than those of the carrier and sidebands associated with normal modulation. The level of spurious emissions shall be measured as:

(a) their power level in a transmission line or antenna, and

(b) their effective radiated power when radiated by the cabinet and structure of the equipment

(b) is also known as “cabinet radiation”.

4.4.2. *Method of measuring the power level*

Spurious emissions shall be measured as the power level of any discrete signal delivered into a 50 ohms load. This may be done by connecting the transmitter output through an attenuator to a spectrum analyser or selective voltmeter or by monitoring the relative levels of the spurious signals delivered to an artificial antenna (Clause 3.5.).
The transmitter shall be unmodulated and the measurements made over the frequency range 100 kHz to 4.000 MHz, except for the channel on which the transmitter is expected to operate and its adjacent channels.
The measurements shall be repeated with the transmitter modulated with normal coded test signal (Clause 3.4.1). If possible this should be a continuous modulation for the duration of the measurement.

4.4.3. *Method of measuring the effective radiated power*

On a test site. fulfilling the requirements of Clause 3.7., the sample shall be placed at the specified height on the support. The transmitter shall be operated without modulation at the carrier power as specified under Clause 4.2., delivered to an artificial antenna.

Radiation of any spurious components shall be detected by the test antenna and receiver, over the frequency range 30-4.000 MHz, except for the channel on which the transmitter is intended to operate and its ad channels.

At each frequency at which a component is detected, the sample shall be rotated to obtain maximum response and the effective radiated power of that component determined by a substitution measurement.

The measurements shall be repeated with the test antenna in the orthogonal polarisation plane. The measurements shall be repeated with the transmitter modulated by the normal coded test signal. If possible this should be continuous modulation for the duration of the measurement.

4.4.4. *Limit*

The power of any spurious emission shall not exceed the values given below

	100 kHz to 1.000 MHz	1.000 MHz to 4.000 MHz
Tx. Operating	0.25 microwatt	1 microwatt
Standby	2 nanowatts	20 nanowatts

4.5. Intermodulation attenuation

This requirement applies only to transmitters to be used in base stations.

Definition

For the purpose of this specification the intermodulation attenuation is a measure of the capability of a transmitter to inhibit the generation of signals in its non-linear elements caused by the presence of the carrier and an interfering signal reaching the transmitter via its antenna.

*4.5.2. Meth*od of *measurement*

The output of the transmitter under test shall be connected to a signal source via a coupling device, presenting to the transmitter a load with an impedance of 50 ohms.

The coupling device can consist of a circulator, one port of which is to be connected by a coaxial cable to the output terminal of the transmitter, the second port is to be correctly terminated (nominal value 50 ohms). This termination is to be provided with means for connection to a selective measuring device (e.g. a spectrum analyser). The third port of the circulator is to be connected to the test signal source by means of an isolator.

Alternatively, the coupling device may consist of a resistive attenuator, which may be combined with an isolator, one end to be connected to the output terminal of the transmitter by coaxial cable and the other end to be connected to the test signal source. A selective measuring device is to be connected to the transmitter end of the attenuator by means of a sampling probe, giving the required attenuation.

The transmitter under test and the test signal source shall be physically separated in such a way that the measurement is not influenced by direct radiation.

The test signal shall be unmodulated and the frequency shall be within 1-4 neighbouring channels above the frequency of the transmitter under test. The frequency shall be chosen in such a way that intermodulation components to be measured do not coincide with other spurious emissions. The test signal power level shall be adjusted to - 30 dB relative to the carrier power level of the transmitter (Clause 4.2.), both levels being measured at the output of the transmitter. The power level of the test signal shall be measured at the transmitter end of the coaxial cable, when disconnected from the transmitter and then correctly matched (nominal value 50 ohms)[3]).

The output power of the transmitter shall be measured directly at the output terminal connected to an artificial antenna (Clause 3.5.).

With the transmitter switched on in an unmodulated condition the levels of the transmitter carrier and the intermodulation components are compared by means of the selective measuring device.

The length of the coaxial cable between the transmitter output and the coupling device shall be varied until the maximum level of the intermodulation component considered is obtained.

This measurement shall be repeated with the test signal at a frequency within 1-4 neighbouring channels below the transmitter frequency.

[3)] *Note.* The impedance that the transmitter presents to the test signal being unknown, the test signal level cannot be measured or its amplitude compared with that of the intermodulation components, while the transmitter is connected.

When the above measurements are performed, precautions must be taken, so that non-linearities in the selective measuring device do not influence the results appreciably. Furthermore it should be ensured that intermodulation components, which may be generated in the test signal source, are sufficiently reduced, e.g. by means of a circulator.
The intermodulation attenuation is expressed as the ratio in dB of the test signal power level to the power level of an intermodulation component.

4.5.3. Limit
The intermodulation attenuation shall be at least 15 dB for any intermodulation component.

Note. For certain special services it may be necessary to have an intermodulation attenuation of at least 40 dB. This may be achieved by means of isolating devices, such as circulators.

5. RECEIVER

The next paragraphs describe the receiver performance specifications. However, it is understood that with the presented methods of measurement the fading phenomena are not taken into account. For those cases, in which it is necessary to take these phenomena into account, the paragraphs concerning “multipath signalling.sensitivity expressed as field strength” are attached to this Annex in Appendix B.

5.1. Reference signalling sensitivity expressed as field strength

5.1.1. Definition
The reference signalling sensitivity is the field strength of a radio frequency signal at the nominal receiver frequency and modulated with the normal coded test signal *which will* produce a successful calling rate of

5.1.2. *Method of* measurement

(a) A signal of carrier frequency equal to the nominal frequency signal (Clause 3.4.l.) in accordance with instructions of the manufacturer shall be applied to the test antenna.
(b) The level of this signal shall be such that a successful calling rate of less than 10% is obtained.
(c) The normal coded test signal shall be transmitted repeatedly whilst observing in each case whether or not a successful response is obtained. The input level shall be increased by 1 dB for each occasion that a successful response is not obtained. The procedure shall be continued until three consecutive successful responses are observed. The level of the input signal shall be recorded.
(d) The input signal level shall be reduced by 1 dB and the new value recorded. The standard coded test signal shall then be transmitted 20 times. In each case, if a response is not obtained the input level shall be increased 1 dB and the new value recorded. If a successful response is obtained, the input level shall not be changed until three consecutive successful responses have been obtained. In this case, the input level shall be reduced by 1 dB and the new value recorded.
Note. No input signal levels shall be recorded unless preceded by a change in level.
(e) The reference signalling sensitivity is the average of the values recorded in steps (c) and (d).
(f) The measurement shall be repeated under extreme test conditions (Clauses 2.4.1. and 2.4.2. of Annex I applied simultaneously).

5.1.3. *Limit*
The reference signalling sensitivity shall not exceed + 6 dB relative to an e.m.f. of one microvolt under normal test conditions, and - 12 dB relative to an e.m.f. of one microvolt under extreme test conditions.

5.2. Co-channel rejection

5.2.1. Definition
The co-channel rejection is a measure of the capability of the receiver to operate to a specified successful calling rate from a wanted signal in the presence of an unwanted modulated signal, both signals being at the nominal frequency of the receiver.

5.2.2. *Method of measurement*

(a) 'Me two input signals shall be connected to the test fixture via a combining network (see also Clause 3.l.). The wanted signal shall be modulated by the normal coded test signal (Clause 3.4..l.). The unwanted signal shall be unmodulated. Both signals shall be at the nominal frequency of the receiver and the measurement shall be repeated for displacements of the unwanted signal of up to ±3.000 Hz.

(b) The amplitude (e.m.f.) of the wanted signal shall be adjusted to the level corresponding to the limit for the reference signalling sensitivity.

(c) The unwanted signal shall then be switched on, and the input level adjusted until a successful calling rate of less than 10% is obtained.

(d) The normal coded test signal shall be transmitted repeatedly whilst observing in each case whether or not a successful response is obtained. The level of the unwanted signal shall be reduced by *2* dB for each occasion that a successful response is *not* obtained. The procedure shall be continued until four consecutive successful responses are observed. The level of the input signal shall then be recorded.

(e) The unwanted input signal level shall be increased by 1 dB and the new value recorded. The standard coded test signal shall then be transmitted *40* times. In each case, if a response is *not* obtained the level of the unwanted signal shall be reduced by 1 dB and the new value recorded. If a successful response is obtained the level of the unwanted signal shall not be changed until four consecutive successful responses have been obtained. In this case the unwanted signal shall be increased by 1 dB and the new value recorded.

Note. No levels of the unwanted input signai level shall be recorded unless preceded by a change in level.

(f) The co-channel rejection ratio shall be expressed as the ratio in dB of the average of the levels of the unwanted signal recorded in steps (d) and (e) to the level of the wanted signal at the receiver input.

5.2.3. *Limits*

The co-channel rejection ratio at the signal displacements, given in the method of measurement shall be greater than:

- 8 dB for a channel separation of *20* kHz and *25* kHz
-12 dB for a channel separation of 12.5 kHz

5.3. **Adjacent channel selectivity**

5.3.1. Definition

The adjacent channel selectivity is a measure of the capability of the receiver to operate to a specified successful calling rate from a wanted signal of a level corresponding to the limit of the reference signalling sensitivity in the presence of an unwanted modulated signal which differs in frequency from the wanted signal by an amount equal to the adjacent channel separation for which the equipment is intended.

5.3.2. Method of measurement

(a) Two signal generators A (providing wanted signal) and B (providing unwanted signal) shall be connected to the receiver via a combining network (see also Clause 3.l.). Signal generator A shall be at the nominal frequency of the receiver and shall be modulated by the normal coded test signal (Clause 3.4.1.). Signal generator B shall be unmodulated and shall be adjusted to the frequency of the channel immediately above that of the wanted signal.

(b) The amplitude (e.m.f.) of the wanted signal shall be adjusted to the level corresponding to the limit for the reference signalling sensitivity.

(c) The unwanted signal shall then 6e switched on and the input level adjusted until a successful calling rate of less than 10% is obtained.

(d) The normal coded test signal shall be transmitted repeatedly whilst observing in each case whether or not a successful response is obtained. The level of the unwanted signal shall be reduced by 2 dB for each occasion that a successful response *is not* obtained. The procedure shall be continued until four consecutive successful responses are observed. The level of the input signal shall then be recorded.

(e) The unwanted input signal level shall be increased by 1 dB and the new value recorded. The standard coded test signal shall then be transmitted *40* times. In each case. if a response is *not* obtained the level of the unwanted signal shall be reduced by 1 dB and the new value recorded. If a successful response is obtained the level of the unwanted signal shall not be changed until four consecutive successful responses have been obtained.

In this case the unwanted signal shall be increased by 1 dB and the new value recorded.

Note. No levels of the unwanted signal shall be recorded unless *preceded* by a change in level.

(f) The measurement shall be repeated with the unwanted signal at the frequency of the channel below that of the wanted signal.

(g) The adjacent channel selectivity shall be expressed as the lower value expressed in dBs, relative to one microvolt e.m.f. of the ratios for the upper and lower adjacent channels of the average of the levels of the unwanted signal recorded in steps (d) and (e) to the level of the wanted input signal (generator A).
(h) The measurement shall be repeated under extreme test conditions. (Clauses 2.4. 1. and 2.4.2. of Annex 1 applied simultaneously).

5.3.3. *Limits*
For channel separations of 20 kHz and 25 kHz, the adjacent channel selectivity shall be not less than 76 dB under normal test conditions and not less than 66 dB under extreme test conditions. For channel separations of 12.5 kHz, the adjacent channel selectivity shall be not less than 66 dB under normal test conditions and not less than 56 dB under extreme test conditions All these limits are expressed in dBs relative to one microvolt e.m.f.

5.4. Spurious response rejection

5.4.1. *Definition*
The spurious response rejection is a measure of the capability of the receiver to operate to a specified successful calling rate from a wanted signal at a level corresponding to the limit of the reference signalling sensitivity, in the presence of an unwanted unmodulated signal at any other frequency.

5.4.2. Method of measurement
(a) Two signal generators A (providing the wanted signal) and B (providing the unwanted signal) shall be connected to the receiver via a combining network (see also Clause 3.). Signal generator A shall be at the nominal frequency of the receiver and shall be modulated by the normal coded test signal (Clause 3.4.1.). Signal generator B shall be unmodulated and shall be adjusted to a frequency at which it is anticipated that a spurious response could occur.
(b) The amplitude (e.m.f.) of the wanted signal shall be adjusted to the level corresponding to the limit for the reference signalling sensitivity.
(c) The unwanted signal shall then be switched on and the input level adjusted until a successful calling rate of less than 10% is obtained.
(d) The normal coded test signal shall then be transmitted repeatedly whilst observing in each case whether or not a successful response is obtained. The level of the unwanted signal shall be reduced by 2 dB for each occasion that a successful response is *not* obtained. The procedure shall be continued until four consecutive successful responses are observed. The level of the input signal shall then be recorded.
(e) The unwanted input signal level shall be increased by 1 dB and the new value recorded. The standard coded test signal shall then be transmitted 40 times.
In each case, if a response is *not* obtained the level of the unwanted signal shall be reduced by 1 dB and the new value recorded. If a successful response is obtained the level of the unwanted signal shall be changed until four consecutive successful responses have been obtained. In this case the unwanted signal shall be increased by 1 dB and the new value recorded.
Note. No levels of the unwanted signal shall be recorded unless preceded by a change in level.
(f) The spurious response rejection shall be expressed as the value in dB of the average of the levels of the unwanted signal recorded in steps (d) and (e).
(g) Within the frequency range 100 kHz-2.000 MHz the measurement shall be repeated at each frequency at which it is anticipated that a spurious response could occur.

5.4.3. *Limits*
At any frequency separated from the nominal frequency of the receiver by an amount exceeding one channel separation, the spurious response rejection shall be greater than 76 dB relative to one microvolt e.m.f.

5.5. Intermodulation response

5.5.1. *Definition*
The intermodulation response is a measure of the capability of the receiver to inhibit the operation of successful decoder responses caused by two equal level unwanted signals,_having specific frequency relationships to the nominal operating frequency, one of which is modulated by the normal coded test signal.

5.5.2. *Method of measurement*

(a) The signal generators A and B shall be applied to the receiver via a combining network (see also Clause3.1). Signal generator A shall be modulated by the normal coded test signal (Clause 3.4. l.) and shall be adjusted to a frequency separated by twice the channel spacing above (or below) the nominal frequency.

Signal generator B shall be unmodulated and shall be adjusted to a frequency separated by one channel separation above (or below) the nominal frequency.

Note. In the following steps, in the cases of RF-modulated PSK or FSK, the complementary modulation may be necessary.

(b) The output levels of the two signal generators shall be kept equal and reduced to a value such that a successful calling rate of less than 10% is obtained.

(c) The normal coded test signal shall be transmitted repeatedly, whilst observing in each case whether or not a successful response is obtained. The input levels shall be increased by 1 dB for each occasion that a successful response is *not* obtained. The procedure shall be continued until three consecutive successful responses are observed. The level of the input signal shall then be recorded.

(d) The input levels shall be reduced by 1 dB and the new value recorded. The standard coded test signal shall then be transmitted *20* times. In each case, if a response is *not* obtained the input levels shall be increased 1 dB and the new value recorded. If a successful response is obtained the input levels shall not be changed until three consecutive successful responses have been obtained. In this case the input levels shall be reduced by 1 dB and the new value recorded.

Note. No input signal levels shall be recorded unless preceded by a change in input level.

(c) The intermodulation response is expressed as the value in dB of the average of the input levels of the two signal generators recorded in steps (c) and (d).

(f) The measurement may be repeated with frequency separations of up to 4 and 8 times the channel separation.

5 5 3 *Limit*[5]*)*

The intermodulation response shall not be less than 70 dB relative to one microvolt e.m.f.

5.6. Blocking

5 6.1. *Definition*

Blocking is an effect whereby the successful calling rate due to a specified wanted signal is reduced due to an unwanted unmodulated signal on another frequency other than those at which a spurious response could occur.

5.6.2. *Method of measurement*

(a) Two input signals shall be applied to the receiver via a combining network (see also Clause 3.1. of Annex 1). The wanted signal shall be at the nominal frequency of 1 receiver and shall be modulated by the normal coded test signal (Clause 1.1.). The amplitude (e.m.f.) of the wanted signal shall be adjusted to the level corresponding to the limit for the reference signalling sensitivity.

(b) The unwanted signal shall be unmodulated and the frequency shall be varied between + 1 MHz and _ + 10 MHz and also between - 1 MHz and - 10 MHz relative to the nominal frequency of the receiver. At any frequency in the specified range, other than those at which a spurious response could occur (see Clause 3.4.) the level of the unwanted signal shall be adjusted until a successful calling rate of less than 10% is obtained.

(c) The normal coded test signal shall then be transmitted repeatedly whilst observing in each case whether or not a successful response is obtained. The level of the unwanted signal shall be reduced by *2* dB for each occasion that a successful response is *not* obtained. The procedure shall be continued until four
consecutive successful responses are observed. The level of the input signal shall then be recorded.

(d) The unwanted input signal shall then be increased by 1 dB and the new value recorded. The standard coded test signal shall then be transmitted 40 times.
In each case, if a response is *not* obtained the level of the unwanted signal shall be reduced by 1 dB and the new value recorded. If a successful response is obtained the level of the unwanted signal shall not be changed until four consecutive successful responses have been obtained. In this case the unwanted signal shall be increased by 1 dB and the new value recorded.
Note. No levels of the unwanted signal shall be recorded unless *preceded* by a change in *level.*

[5]) It is foreseen that this limit will be increased to 76 dB

(c) The blocking level is the average of the levels of the unwanted signal recorded in steps (c) and (d) for the frequency concerned.

5.6.3. *Limit*
The blocking level for any frequency in the specified ranges shall be not less than +90 dB relative to one microvolt e.m.f. except at frequencies on which spurious responses are found (Clause 5.4).

5.7. **Spurious emissions**

5.7.1. *Definition*
Spurious emissions are any emissions from the receiver.
The level of spurious emissions shall be measured by: (a) their power level in a transmission line or antenna and (b) their effective radiated power when radiated by the cabinet and structure of the equipment; (b) is also known as "cabinet radiation".

5.7.2. *Method of measuring the power level*
Spurious emissions shall be measured as the power level of any discrete signal at the input terminals of the receiver. The receiver input terminals are connected to a spectrum analyser or selective voltmeter having an input impedance of *50* ohms and the receiver is switched on.
If the detecting device is not calibrated in terms of power input, the level of any detected components shall be determined by a substitution method using a signal generator.
The measurements shall extend over a frequency range of 100 kHz to 4.000 MHz.

5.7.3. *Method of measuring the effective radiated power*
On a test site fulfilling the requirements of Clause 3.7., the sample shall be placed at the specified height on the support. The receiver shall be operated from a power source via a radio frequency filter to avoid radiation from the power leads. The antenna terminal shall be terminated with a non-reactive, non-radiating load of 50 ohms.
Radiation of any spurious components shall be detected by the test antenna and receiver over the frequency range 30-4.000 MHz.
At each frequency at which a component is detected, the sample shall be rotated to obtain maximum response and the effective radiated power of that component determined by a substitution measurement.
The measurements shall be repeated with the test antenna in the orthogonal polarisation plane.

5.7.4. *Limit*
The power of any spurious emissions in the range 100 kHz to 1,000 MHz shall not exceed *2* nanowatts, and in the range 1.000 MHz to 4.000 MHz shall not exceed 20 nanowatts.

6. PRESENTATION OF SINGLE AND MULTICHANNEL EQUIPMENT FOR TYPE APPROVAL

6.1. **Choice of model for type approval**
The manufacturer shall provide a production model of the equipment, for type approval testing. If type approval is given on the basis of tests on a preliminary model. then the corresponding production models must be identical in all respects with the preliminary model tested.

6.2 **Single-channel equipment**
Any channel within the specified frequency range may be selected for type approval testing. The choice shall be approved by the testing authority.

6.3 **Multichannel equipment**
Type approval tests need to be carried out only on the highest and lowest channels within the switching range of the equipment and on a channel near the middle of the switching range, except in special circumstances. The switching range shall be declared by the manufacturer. The choice of channels for type approval testing shall be approved by the testing authority.

7. ACCURACY OF MEASUREMENT

The tolerance for the measurement of the following parameters shall be as given below:

7.1.1.	DC voltage	± 3%
7.1.2.	AC mains voltage	± 3%
7.1.3.	AC mains frequency	± 0.5%
7.2.1.	Radio frequency	± 50 Hz
7.2.2.	Radio-frequency voltage	± 2 dB
7.2.3.	Radio-frequency field strength	± 3 dB
7.2.4.	Radio-frequency carrier power	± 10%
7.2.5.	Radio-frequency adjacent channel power	± 3 dB
7.3.1.	Impedance of artificial loads, combining units, cables, plugs, attenuators, etc.	± 5%
7.3.2.	Source impedance of generators and input impedance of measuring receivers	± 10%
7.3.3.	Attenuation of attenuators	± 0.5 dB
7.4.1.	Temperature	± 1° C
7.4.2.	Humidity	± 5%

Appendix A/V

GUIDANCE ON THE USE OF RADIATION TEST SITES

For measurements involving the use of radiated fields. use may be made of a test site in conformity with the requirements of paragraph 3.7. of this Annex. When using such a test site, the following conditions should be observed to ensure consistency of measuring results.

A.1. Measuring distance

Evidence indicates that the measuring distance is not critical and does not significantly affect the measuring results, provided that the distance is not less than $\lambda/2$ at the frequency of measurement, and the precautions described in this Annex are observed.

Measuring distances of 3 m, 5 m, 10 m and 30 m are in common use in the CEPT countries.

A.2. Test antenna

Different types of test antennae may be used, since in performing substitution measurements, calibration errors of the test antenna do not affect the measuring results.

Height variation of the test antenna over a range of 1-4 metres is essential in order to find the point at which the radiation is a maximum.

Height variation of the test antenna may not be necessary at the lower frequencies below about 100 MHz.

A.3. Substitution antenna

Variations in the measuring results may occur with the use of different types of substitution antennae at the lower frequencies below about 80 MHz. Where a shortened dipole antenna is used at these frequencies, details of the type of antenna used should be included with the results of the tests carried out on the site.

A.4. Artificial antenna

The dimensions of the artificial antenna used during case radiation measurements should be small in relation to the sample under test.

Where possible. a direct connection should be used between the artificial antenna and the test sample.

In cases where it is necessary to use a connecting cable, means should be taken to reduce the radiation from this cable by, for example, the use of ferrite cores.

A.5. Auxiliary cables

The position of auxiliary cables (power supply and microphone cables. etc.) which are not adequately decoupled may cause variations in the measuring results. In order to get reproducible results, cables and wires of auxiliaries are mounted vertically downwards (through a hole in isolating table or in the base plate of the salt water column), and shall be fitted in their upper part with a radio frequency stop filter (by means, for example, of ferrite tubes).

Appendix B/V

FADING SIMULATOR TEST PROCEDURE

The use of a realistic radiopath will generally lead to the occurrence of fading. Especially in systems where data is transmitted it may be necessary to take the effect of this fading phenomena into account for the testing of equipment, as it may influence the fitness of receivers for the planned frequency management. Therefore, in this Appendix, the “multipath signalling sensitivity” expressed as field strength is described.

1. Multipath signalling sensitivity expressed as field strength

1.1. *Definition*

The multipath signalling sensitivity is the rms value of the field strength of a rayleigh fading signal at the nominal receiver frequency and modulated with the normal coded test signal which will produce a successful calling rate of 80%.

1.2. *Methods of measurement*

(a) A signal of carrier frequency equal to tile nominal frequency or the receiver and modulated with the normal coded test signal in accordance with the instructions of the manufacturer shall be applied to the test antenna through the rayleigh fading simulator, set for 90 km/hr.

(b) The level of this signal shall be such that a successful calling rate of less than 10% is obtained.

(c) The normal coded test signal shall be transmitted repeatedly whilst observing in each case whether or not a successful response is obtained. The input level shall be increased by 1 dB for each occasion that a successful response is *not* obtained. The procedure shall be continued until three consecutive successful responses are observed. The rms level of the input signal shall then be recorded.

(d) The input signal level shall be reduced by 1 dB and the rms value recorded. The standard coded test signal shall 40 times. in each cases, if a response is *not* obtained the input level shall be increased 1 dB and the new value recorded. If a successful response is obtained, the input level shall not be changed until three consecutive successful responses have been obtained. In this case, the input level shall be reduced by 1 dB and the new value recorded.
Note. No input signal levels shall be recorded unless *preceded* by a change in level.

(e) The reference signalling sensitivity is the average of the values recorded in steps (c) and (d).

(f) The measurement shall be repeated with the rayleigh fading simulator set for 50 km/hr and 10 km/hr.

1.3. *Limit*

The multipath signalling sensitivity should not exceed + 6 dB relative to an e.m.f. of 1 μV under normal test conditions.

Appendix to Recommendation T/R 24-01

This Appendix contains in annex additional information concerning the national derogations and options exercised in the implementation of Recommendation T/R 24-01. It has been compiled by the "Radiocommunications" Working Group T/GT 3 and distributed by the liaison office of the CEPT. Since this is information provided by the Administrations, the contents have not been formally approved by the "Telecommunications" Committee.

T/R 24-01
Appendix to Annex I (revised version, Cannes, 1983)

Paragraph	Administration	Description of variation or choice	Reason
General	France	"M" Factor for receiver measurements omitted (5.4.3., 5.5.3. and 5.6.1.)	
	Germany (Fed. Rep.)	Implementation planned	
	Ireland	Implementation planned, variations as follows Channel separation (68-170 MHz): 12.5 kHz Channel separation (420-470 MHz): 25 kHz	
	Spain	Implementation planned	
	Sweden	Implementation planned	
	Switzerland	Implementation planned soon, variations as shown below	
	United Kingdom	Implementation planned. variations as follows Channel separation (70-170 MHz): 12.5 kHz Channel separation (420-470 MHz): 25 kHz	
2.4.1.	Austria	Extreme temperatures: -20° C and +55° C	Choice possible
	Belgium	Extreme temperatures: -10° C and +55° C	Choice possible
	Denmark	Extreme temperatures: -20° C and +55° C	Choice possible
	Finland	Extreme temperatures: -25° C and +55° C	
	France	Extreme temperatures: -10° C and +55° C (on request: -20° C and -55° C)	Choice possible
	Germany	Extreme temperatures: -10° C and +55° C	Choice possible
	Greece	Extreme temperatures: -20° C and +55° C	Choice possible
	Ireland	Extreme temperatures: -10° C and +55° C	Choice possible
	Norway	Extreme temperatures: -25° C and +55° C	Choice possible
	Netherlands	Extreme temperatures: -10° C and +55° C	Choice possible
	Switzerland	Extreme temperatures: -20° C and +55° C	Choice possible
	United Kingdom	Extreme temperatures: -10° C and +55° C	Choice possible
3.7.	Greece	Implementation planned	
3.7.1.	Norway	Test site-testing distance: 30 m Height of test sample: 1 metre	
3.7.4	France	Indoor test site	Not used
	Germany	Indoor test site	
4.1.3.	France	Frequencies below 50 MHz (adjacent channel separation of 12.5 kHz) frequency tolerance: ± 0.6 kHz	Not specified in the Recommendation
	Ireland	Frequency tolerance for adjacent channel separation of 12.5 kHz 68-300 MHz): ± 2 kHz	
	Switzerland	Frequencies in the range 500 to 1.000 MHz, adjacent channel separation of 20 and 25 kHz: same test conditions and frequency tolerance (± 2.5 kHz) for all equipment (including portable equipment)	
	United Kingdom	Frequency tolerance for adjacent channel separation of 12.5 kHz (100-300 MHz): ± 2 kHz	
4.2.3.	Denmark	Includes maximum power 25 W	
	Norway	Power limits: mobile stations 15 W max private base stations 25 W max public base stations 60 W max	
4.3.2.	France	Modulation frequencies higher than 3 kHz: substitute 2.55 kHz for 3 kHz for channel separations of 12.5 kHz	Reduction of spectrum

T/R 24-01
Appendix to Annex I (revised version, Cannes, 1983)

Paragraph	Administration	Description of variation or choice	Reason
4.4.2.1.	—	Method of measurement for adjacent channel power.	
	Austria	Both methods possible, a power measuring receiver is generally used	Choice possible
	Belgium	Spectrum analyser	Choice possible
	Denmark	Power measuring receiver	Choice possible
	Finland	Power measuring receiver	Choice possible
	France	Spectrum analyser (preferred method)	Choice possible
	Germany	Both methods are used	Choice possible
	Greece	Power measuring receiver	Choice possible
	Ireland	Power measuring receiver	Choice possible
	Netherlands	Power measuring receiver	Choice possible
	Switzerland	Power measuring receiver	Choice possible
	United Kingdom	Power measuring receiver	Choice possible
4.4.3.	Ireland	Adjacent channel power limit: 65 dB (25 kHz separation) 55 dB (12.5 kHz separation)	
	United Kingdom	Adjacent channel power limit: 65 dB (25 kHz separation) 55 dB (12.5 kHz separation)	
4.5.2.	Greece	Range: 100 kHz-1.2 GHz	
4.5.3.	Greece	Implementation planned	
4.5.4.	Austria	Spurious emissions limit: 2.5 µW	Note. Reduction to 0.25 µW planned
	Belgium	Spurious emissions limit: 2.5 µW	
	Denmark	Spurious emissions limit: 2.5 µW	
	Ireland	Spurious emissions limit: 2.5 µW	
	Norway	Spurious emissions limit: 2.5 µW (artificial antenna) 300 µV/M at 30 m (cabinet radiation)	
	United Kingdom	Spurious emissions limit: 2.5 µW	
4.6.	Denmark	Not specified	
	Finland	Not specified	
	Ireland	Not specified	
	United Kingdom	Not specified	
5.1.	—	Method of measurement for receiver sensitivity	
	Austria	Both methods are allowed. S + N + DIN is generally used	Choice possible
	Belgium	S - N + D/N + D	Choice possible
	Denmark	S + N + D/N + D	Choice possible
	France	S + N + D/N (preferred method)	Choice possible
	Germany	S + N + D/N	Choice possible
	Greece	S + N + D/N + D	Choice possible
	Ireland	S + N D/N + D (ratio of 12 dB without weighting)	
	Netherlands	S + N + D/N	Choice possible
	Norway	S + N + D/N + D	Choice possible
	Switzerland	S - N + D/N	Choice possible
	United Kingdom	S + N + D/N + D (ratio of 12 dB without weighting)	
5.2.	Ireland	Not specified	
	United Kingdom	Not specified	
5.3	Ireland	Not specified	
	United Kingdom	Not specified	

T/R 24-01
Appendix to Annex I (revised version, Cannes,

Paragraph	Administration	Description of variation or choice	Reason
5.4.3.	Switzerland	Adjacent channel selectivity of equipment with channel separation of 20 and 25 kHz; operated at between 862 and 960 MHz: limits of 64 and 54 dB respectively under normal conditions and extreme conditions	
5.5.3.	Ireland	Spurious response protection radio: 60 dB	
	United Kingdom	Spurious response protection radio: 60 dB	
5.6.3.	Ireland	Intermodulation protection radio: 60 dB	
	Switzerland	Intermodulation protection limit: 76 dB µV e.m.f. (except equipment operated at between 862 and 960 MHz: 70 dB µV e.m.f.)	
	United Kingdom	Intermodulation protection radio: 60 dB	
5.8	Germany	Limits are also imposed in the frequency range 10 kHz to 30 MHz: 1. For the magnetic component of the interfering field radiated by the equipment and, where relevant, by the power leads 2. Where relevant, for voltage produced by conduction in the mains power leads (of particular importance where base stations are concerned)	For frequencies below 30 MHz, the Substitution method poses problems
5.8.2.	Greece	Frequency range: 100 kHz to 1.2 GHz	
5.8.4.	Ireland	Receiver spurious emissions limit: 20 nW	
	United Kingdom	Receiver spurious emissions limit: 20 nW	

T/R 24-01
Appendix to Annex II (revised version, Stockholm,

Paragraph	Administration	Description of variation or choice	Reason
General	Austria	Annex not applied	
	Greece	Characteristics not required for type approval	
	Ireland	Annex not applied	
	Sweden	Annex not applied	
	Switzerland	Characteristics not required for type approval	
5.	France	The constant input level method is preferred	Choice possible
	Norway	Constant deviation method	Choice possible

T/R 24-01
Appendix to Annex III (revised version, Cannes, 1983)

Paragraph	Administration	Description of variation or choice	Reason
General	Denmark	Publication of Annex III in preparation	
	France	Publication of Annex III in preparation	
	Germany	Implementation planned	
	Greece	Implementation planned	
	Ireland	Implementation planned. variations as follows: Channel separation (68-170 MHz): 12.5 kHz Channel separation (420-470 MHz): 25 kHz	
	Sweden	Annex not implemented	
	Switzerland	Implementation planned soon, choices and variations as indicated below	
	United Kingdom	Implementation planned. variations as follows: Channel separation (70-170 MHz): 12.5 kHz Channel separation (420-470 MHz): 25 kHz	
2.4.1.		Extreme temperatures: -20° C and +55° C	
	Austria	Extreme temperatures: -10° C and +55° C	Choice possible
	Belgium	Extreme temperatures: -20° C and +55° C	Choice possible
	Denmark	Extreme temperatures: -25° C and +55° C	Choice possible
	Finland	Extreme temperatures: -10° C and +55° C	Choice possible
	Germany	Extreme temperatures: -10° C and +55° C	Choice possible
	Ireland	Extreme temperatures: -20° C and +55° C	Choice possible
	Switzerland	Extreme temperatures: -10° C and +55° C	Choice possible
	United Kingdom		Choice possible
3.7.4.	Germany	Indoor measurement site	
4.1.3.	Ireland	Frequency tolerance for 12.5 kHz in the band 68-300 MHz: ±2 kHz	
	Switzerland	Frequencies in the range 500 to 1.000 MHz, adjacent channel separation of 20 and 25 kHz: same test conditions and frequency tolerance (±2.5 kHz) for all equipment (including portable equipment)	
	United Kingdom	Frequency tolerance for 12.5 kHz in the band 100-300 MHz: ± 2 kHz	
4.4.2.1.		Method of measurement for adjacent channel power	
	—	Both methods possible, a power measuring receiver is generally used	
	Austria	Spectrum analyser	Choice possible
	Belgium	Power measuring receiver	
	Denmark	Power measuring receiver	Choice possible
	Finland	Both methods are used	Choice possible
	Germany	Power measuring receiver	Choice possible
	Ireland	Power measuring receiver	Choice possible
	Switzerland	Power measuring receiver	Choice possible
	United Kingdom		Choice possible
4.4.3.	Ireland	Adjacent channel power limit: 65 dB (25 kHz separation) 55 dB (12.5 kHz separation)	Choice possible
	United Kingdom	Adjacent channel power limit: 65 dB (25 kHz separation) 55 dB (12.5 kHz separation)	
4.5.	Austria	Spurious emissions limit: 2.5 µW	
	Belgium	Spurious emissions limit: 2.5 µW	
	Ireland	Spurious emissions limit: 2.5 µW	
	Switzerland	Spurious emissions limits transmitter in “transmit” position: in the range 100 kHz-1.000 MHz: 0.25 µW in the range 1.000 MHz-4.000 MHz: 1 µW recommended maximum value in the range 100 kHz-1.000 MHz: 20 nW transmitter in “standby” position: in the range 100 kHz-1.000 MHz: 2 nW in the range 1.000 kHz-4.000 MHz: 20 nW	

T/R 24-01
Appendix to Annex III (revised version, Cannes, 1983)

Paragraph	Administration	Description of variation or choice	Reason
4.5.	United Kingdom	Spurious emissions limit: 2.5 µW	
5.1.	—	Method of measurement for receiver sensitivity	
	Austria	Both methods are possible, S + N + D/N is normally used	Choice possible
	Belgium	S + N + D/N + D	Choice possible
	Germany	S + N + D/N	Choice possible
	Ireland	S + N + D/N + D (ratio of 12 dB without weighting)	
	Switzerland	S + N + D/N	Choice possible
	United Kingdom	S + N + D/N + D (ratio of 12 dB without weighting)	
5.1.3.	Austria	Limit: 26 dB (µW/m) normal test conditions) Limit: 32 dB (µW/m) (extreme test conditions)	
	Germany	Depends on the current	
5.2.	Ireland	Not specified	
	United Kingdom	Not specified	
5.3.	Ireland	Not specified	
	United Kingdom	Not specified	
5.4.3.	Germany	Depends on the current	
	Switzerland	Adjacent channel selectivity limit for channel separation of 20 and 25 kHz in the 900 MHz band = 96 dB µV/m	
5.5.3.	Austria	Spurious response protection ratio: 40 MHz band: 68 dB (µV/m) 80 MHz band: 74 dB (µV/m) 160 MHz band: 82 dB (µV/m) 460 MHz band: 90 dB (µV/m)	
	Germany	Depends on the current	
	Ireland	Spurious response protection radio: 60 dB (µV/m)	
	Switzerland	Spurious response protection ratio: 60 dB (µV/m)	
	United Kingdom	Spurious response protection radio: 60 dB (µV/m)	
5.6.3.	Germany	Depends on the current	
	Ireland	Intermodulation protection ratio: 66- 88 MHz band: 64 dB (µV/m) 154-174 MHz band: 72 dB (µV/m) 420-470 MHz band: 80 dB (µV/m)	
	Switzerland	Intermodulation, ratio protection ratio. 900 MHz band: 96 dB (µV/m)	
	United Kingdom	Intermodulation protection ratio: 71.5- 88 MHz band: 64 dB (µV/m) 105-141 MHz band: 68 dB (µV/m) 156-174 MHz band: 72 dB (µV/m) 425-470 MHz band: 80 dB (µV/m)	
	Ireland	Receiver spurious emissions limit: 20 nW	
5.7.3.	Switzerland	Receiver spurious emissions limit: 20 nW in the band 100 kHz to 1.000 MHz: 2 nW in the band 1.000 MHz to 4.000 MHz: 20 nW	
	United Kingdom	Receiver spurious emissions limit: 20 nW	

T/R 24-01
Appendix to Annex IV (adopted, Ostend, 1979)

Paragraph	Administration	Description of variation or choice	Reason
General	Austria	Annex not applied	
	Denmark	Publication of Annex IV in preparation	
	France	Publication of Annex IV in preparation	
	Germany	Annex not implemented	
	Greece	Implementation planned	
	Ireland	Annex not implemented	
	Sweden	Annex not implemented	
	Switzerland	Characteristics not required for type approval	
	United Kingdom	Annex not implemented	